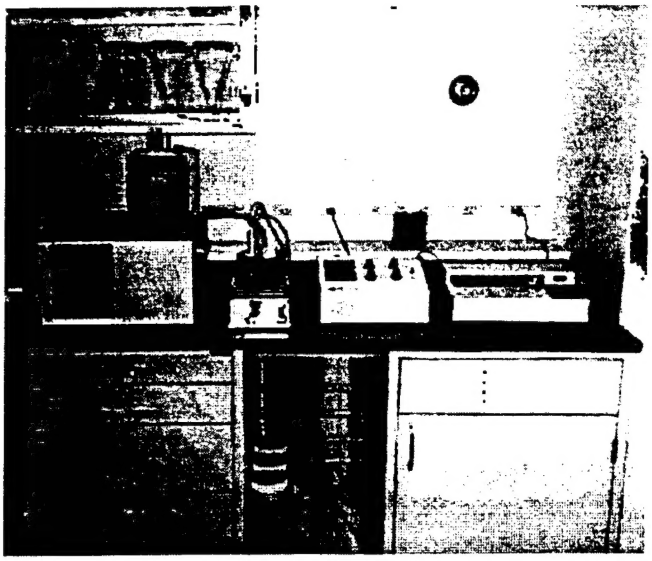

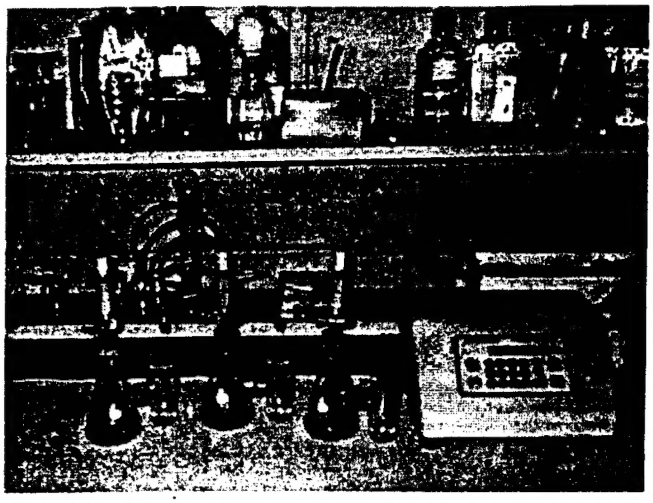

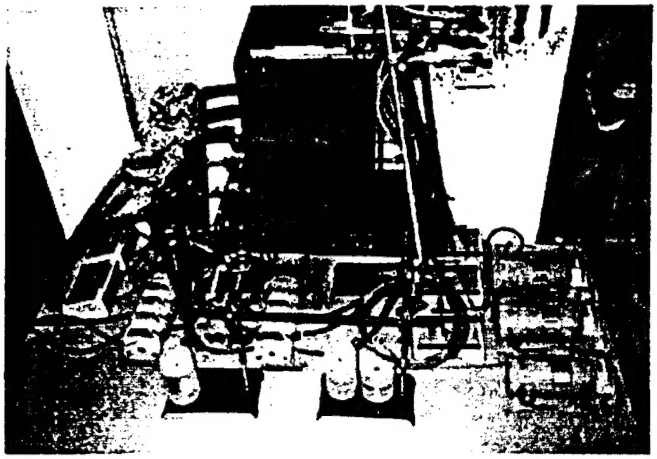

REPORT

FINAL

BIODEGRADABILITY OF DETERGENTS AND ITS EFFECTS ON MUNICIPAL WASTEWATER ACTIVATED SLUDGE

To

THE AEROSPACE GUIDANCE AND METROLOGY CENTER

NEWARK AIR FORCE BASE

SEPTEMBER 17, 1993

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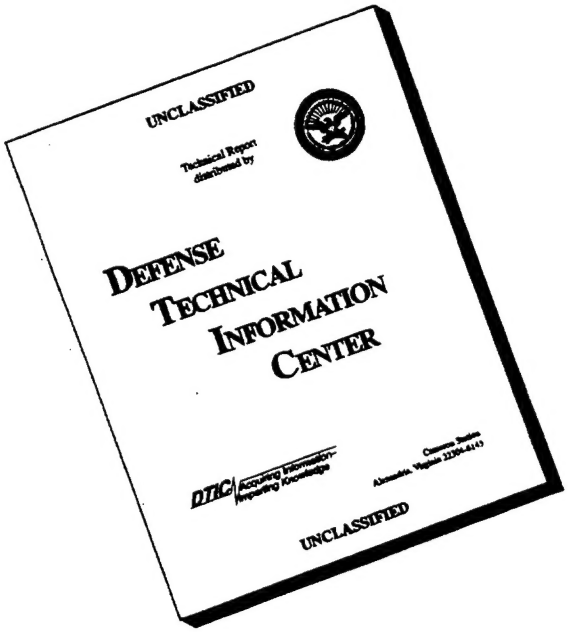

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FINAL REPORT

on

BIODEGRADABILITY OF DETERGENTS AND ITS EFFECTS ON MUNICIPAL WASTEWATER ACTIVATED SLUDGE

Contract No. F04606-89-D-0034-Q806

to

AEROSPACE GUIDANCE AND METROLOGY CENTER
NEWARK AIR FORCE BASE

September 14, 1993

BATTELLE
505 KING AVENUE
COLUMBUS, OHIO

EXECUTIVE SUMMARY

Battelle was contracted by the United States Air Force to conduct a laboratory study to examine the potential impacts, as well as the fate, of 20 detergents on the wastewater treatment plant in Heath, Ohio. The 20 detergents selected for this study were being considered for use by the Aerospace Guidance and Metrology Center located at Newark Air Force Base in Newark, Ohio, as substitutes for various types of solvents. The study was conducted in three phases. The first phase evaluated the inhibition potential of the detergents based on the concentration-dependent changes in the respiration of activated sludge cultures. The second phase examined the potential fate of the detergents by monitoring their biodegradation. The final phase was conducted to determine how two types of washwater might impact the wastewater treatment plant in Heath, Ohio, the plant that receives Newark Air Force Base's wastewater. All experiments were conducted using cultures obtained from the Heath plant. In order to be able to monitor the effects of the detergents, the experiments were conducted at detergent concentrations much higher than the Heath plant would experience.

The results from the first phase of the study indicated that the detergents were inhibitory to the activated sludge cultures. The concentrations at which the detergents inhibited the cultures were much higher than would be seen at the Heath plant even under a "worst case" scenario. Based on the potentials for discharge of these washwaters from Newark Air Force Base, it was concluded that there would be no significant impact on the respiration of the activated sludge organisms at the Heath plant.

The third-phase bench-scale activated sludge study was conducted at a detergent loading more than 37 times higher than for the "worst case" scenario. This was necessary to allow for monitoring changes in the chemical oxygen demand following detergent additions. The results indicated that, at this high concentration, both types of washwater impacted the respiration and chemical oxygen demand (COD) removal performance of the activated sludge cultures. On average, the respiration rates returned to normal levels within 48 hours for both washwater types. The COD of the effluent for the washwater containing Versa-clean returned to the preinjection level within 5 hours. The cultures removed approximately 70% of the chemical oxygen demand from the injection of Formula 815 GD within 5 hours.

Based on the results of this study, it is concluded that discharges from normal operations of the Aerospace Guidance and Metrology Center at Newark Air Force Base would have no significant impact on the operation, performance, or effluent characteristics at the Heath wastewater treatment plant.

ACRONYM LIST

AGMC	Aerospace Guidance and Metrology Center
AFB	Air Force Base
BOD	Biochemical Oxygen Demand
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
DOD	U.S. Department of Defense
EPA	U.S. Environmental Protection Agency
KOH	Potassium Hydroxide
MSDS	Material Safety Data Sheet
O_2	Oxygen
ODC	Ozone Depleting Compound
TS	Total Solids
TSS	Total Suspended Solids
VS	Volatile Solids
WWTP	Wastewater Treatment Plant
YSI	Yellow Springs International

TABLE OF CONTENTS

APPENDICES

TABLE OF CONTENTS
(Continued)

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS
(Continued)

LIST OF TABLES
(Continued)

BIODEGRADABILITY OF DETERGENTS AND ITS EFFECTS ON MUNICIPAL WASTEWATER ACTIVATED SLUDGE

Final Report

1.0 INTRODUCTION

The Aerospace Guidance and Metrology Center (AGMC), located at Newark Air Force Base in Newark, Ohio, is responsible for the repair of inertial navigation and guidance equipment for the U.S. Air Force and other branches of the U.S. Department of Defense (DOD). Activities at the AGMC include the precision cleaning of delicate and sophisticated electromechanical parts, for which the facility has been using various solvents including 1,1,1-trichloroethane and Freon-113™.

These solvents have been classified as ozone-depleting chemicals (ODCs). The U.S. Environmental Protection Agency (EPA) has developed regulations to decrease and eventually eliminate the production and use of ODCs. In response, the Air Force has adopted a policy to eliminate the use of ODCs by the end of 1994. Their elimination will require the use of substitute cleaners that can meet the stringent cleaning requirements for the electronic equipment without damaging the substrate, and which also will not pose an adverse problem for the municipal wastewater treatment plant that would receive the substitutes in its influent.

To eliminate the use of ODCs, the AGMC is planning to switch to aqueous cleaning processes that use water-based detergents. Battelle was contracted to conduct a comprehensive study to evaluate the inhibition potential, biodegradability, and potential fate of up to 20 detergents in a municipal wastewater treatment plant. The detergents tested were those being considered for use by the AGMC as substitutes for the ODCs.

Newark Air Force Base wastewater is discharged to the Heath Municipal Wastewater Treatment Plant (WWTP) in Heath, Ohio. Experiments conducted during this study were designed to investigate how the detergents might impact this treatment plant. This study was one of several studies sponsored by the AGMC. The results from these studies can be used to assist in the selection of the best or most suitable detergents for use by the AGMC.

2.0 OBJECTIVES

There were three phases to the technical part of this study. Each phase had separate objectives that are described in Sections 2.1, 2.2, and 2.3.

2.1 Phase I: Respiration Rate Study

The respiration rate study was conducted to determine what impact the addition of the selected detergents to the wastewater could have on the microbial activity of the activated sludge organisms at the Heath WWTP. Table 1 shows the 20 detergents that were tested. To obtain representative data, experiments were conducted using cultures and wastewater from the WWTP. The results from this study were to be used to select the detergents that warranted further study in Phase II. Detergents that were highly inhibitory (i.e., inhibit microbial respiration at low concentrations) were to be determined unsuitable for use by AGMC and eliminated from further testing.

2.2 Phase II: Biodegradation Potential Study

The biodegradation potential study was conducted to determine what the potential fate of the detergents would be when they were introduced to the Heath WWTP. For this study, biodegradation was defined as the reduction in chemical oxygen demand (COD) between cultures that had a known volume of detergent added and control cultures that did not have detergent added. The biodegradability of the detergents was determined using activated sludge cultures obtained from the Heath plant. The results from this phase of the study indicated whether the detergents could be removed by the bacteria, or if they might pass through the plant and be discharged in the effluent or accumulated in the sludge.

2.3 Phase III: Bench-Scale Activated Sludge System Study

Bench-scale activated sludge plants were constructed and operated to provide information on how the selected detergents might affect the performance of the Heath WWTP. The bench-scale units were inoculated with organisms from the Heath plant and settled primary was used as the influent

Table 1. Detergents Tested in Phase I Respiration Experiments.

Detergent I.D. #	Detergent Trade Names/Manufacturer
1	Versaclean/Ken Crowe Inc.
2	Intex 8284 (MSI 1084)/Magnasonics Systems Inc.
3	EZE 244 (MSI 7000)/Magnasonics Systems Inc.
4	EZE 240/Magnasonics System Inc.
5	Formula 815 GD/Brulin & Co.
6	Brulin 815 QR/Brulin & Co.
7	Intex 8125/Intex
8	Oakite Liquid Detergent #2/Oakite Products
9	Citranox/Alconox
10	Aqua #1/Selectron
11	Cavi-Clean Detergent/Molecular Products
12	MSI 1025/Intex
13	MA-102/JAD Chemical Inc.
14	Oakite Cellutech FW X91/Oakite Products
15	PF Degreaser/P-T Technology
16	Simple Green/Sunshine
17	Titron X-100/National Diagnostics
18	Ultraclean 8700/Magnavue
19	Aquanox X-2031/Kyzen
20	Hurri-Safe/Hurri Clean Corp.

feed. The primary objectives of this study were to determine what effect the detergent/washwater(s) could have on the Heath plant under expected conditions and what impact they would have under a worst-case scenario. The impact of each washwater type was monitored by measuring the COD of the effluent. Effluent COD was used as the indicator of plant performance.

3.0 BACKGROUND

Newark AFB employs approximately 1,600 people and contributes approximately 94,000 gallons of wastewater to the Heath WWTP, daily. This wastewater originates from various activities around the base including lavatory use and a full-service kitchen. The majority of the flow from Newark AFB occurs during the daytime due to the increased activity at the base. During this time the detergent washwaters are expected to be discharged to the Heath WWTP.

For this study, a "worst case" scenario was defined both to determine the most severe impact of detergents from Newark AFB on the Heath WWTP, and to facilitate analyses of the impacts. The worst case scenario was developed based on the eventual use of 16 wash stations, each using 5 gallons of a 100% detergent cleaning solution. This scenario led to a potential contribution of 80 gallons if all baths were discharged simultaneously. To further define the worst case scenario, it was assumed that the detergent would not mix with the wastewater already being discharged from the base and that there would be no mixing or dilution of the detergent en route to the Heath WWTP. These assumptions led to a potential contribution of 6.7×10^{-3}% on a volume/volume basis. This was determined to be the starting point for these experiments. Variations from this concentration and the reasons for needing to vary from this concentration are described in the body of this report.

The expected conditions need to be addressed, to put things in proper perspective. Under normal operating conditions, the baths would operate using a 2 to 5% detergent solution. It is expected that only two to three baths would be changed at one time. The washwater would be mixed with the wastewater discharge from the base and then subsequently mixed with the other wastewater influents en route to the Heath WWTP. It was not possible to determine the extent of mixing and dilution, however. Even without considering the effect of dilution, the maximum detergent concentration would be approximately 6.3×10^{-5}% (vol/vol). This concentration was far too low to allow testing at this level, and the results described within this report indicate that the detergents would not have any detectable impacts at a concentration this low.

4.0 SCOPE

The scope of the research discussed in this report covered several areas of concern for contributions to wastewater treatment plants. The first set of experiments was designed to examine the inhibitory effects of the detergents on biological cultures from the receiving WWTP. The second set was conducted to determine the potential fate of the detergents through the WWTP. The final set was run at bench-scale level to examine the potential impact of the detergents on the activity in and performance of the Heath WWTP.

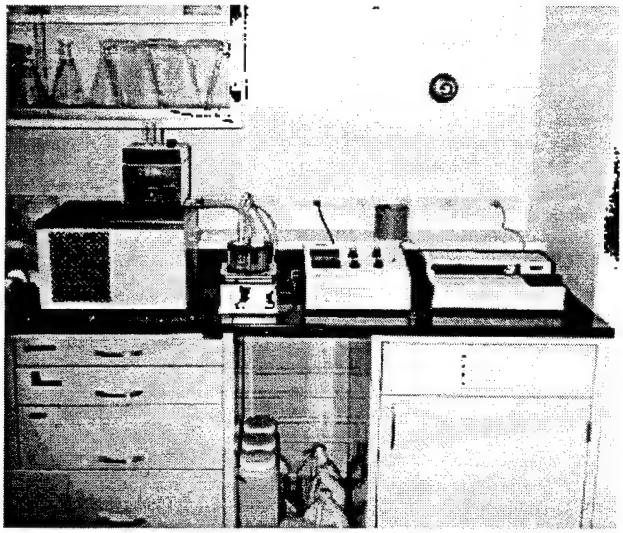
5.0 DETERMINATION OF DETERGENT CHARACTERISTICS

The detergents tested in Phase I are listed in Table 1. Any available physical and chemical data for these detergents were collected from existing Material Safety Data Sheets (MSDSs) and other product information literature. These materials provided limited data that proved useful for this study.

6.0 EXPERIMENTAL METHODS

All experiments were conducted using cultures and wastewater obtained from the Heath WWTP. All culturing of the organisms was done under conditions that simulate the average conditions in the treatment plant. The experimental methods specific to each phase of this study are described in the following sections.

6.1 Phase I: Respiration Rate Study



Wastewater samples and cultures were collected on Tuesday afternoon of each of 6 consecutive weeks. Samples were collected in ½-gallon Nalgene™ containers which were placed on ice in an insulated cooler and transported to the laboratory at Battelle. The samples were refrigerated at 4°C upon arrival at the laboratory.

One sample container of the activated sludge was used for each day of testing. The activated sludge was kept on ice during the day's activities, and the ice was replaced as needed to maintain the samples for the duration of the tests. The activated sludge was oxygenated and completely mixed by vigorously injecting air into the container for several minutes prior to withdrawal of each sample. Air was injected by connecting an aeration stone to a compressed air source and inserting the stone into the bottom of the activated sludge in the bottle. The airflow rate was maintained at the maximum rate that provided adequate aeration and did not promote excess foaming or spillover.

To simulate plant conditions, the respiration experiments were conducted at a constant temperature of 25°C. The temperature was maintained by connecting a constant-temperature circulating bath to the respiration apparatus shown in Figure 1. Respiration measurements were made using a YSI Model 5300 biological oxygen monitor system, and the data were collected on a Linear Dual-Channel Strip-Chart Recorder.

Prior to conducting the experiments, a blank run was conducted to derive a baseline oxygen utilization curve and to verify the operation and performance of both oxygen monitoring channels. Each run was conducted by pipetting 10 mL of activated sludge into each of two glass reaction chambers. An oxygen probe was inserted into each chamber, the samples were continuously stirred

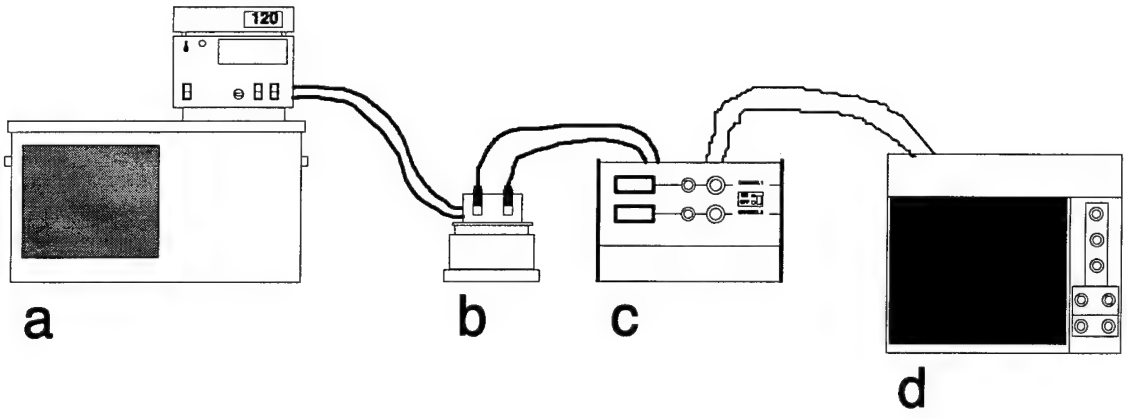


Figure 1. Respiration Apparatus Used in the Detergent Biodegradability Study. a. Constant-Temperature Circulating Bath; b. 4-Chamber Reaction Vessel; c. Dual-Channel Oxygen Meter; d. Dual-Channel Strip Chart Recorder.

and the oxygen utilization was recorded on the dual-channel strip-chart recorder that was attached to the YSI oxygen meter. After the oxygen utilization become limited, as observed by a deviation from the linear part of the utilization curve, the experiment was terminated.

The inhibitory effects the detergents had on respiration were examined after verification of the equipment operation and performance and the development of a baseline oxygen utilization curve. Experimental runs were performed using each of the 20 detergents included in the study. Known volumes of detergents were added to one of the chambers to achieve a desired concentration, and a test chamber that did not receive detergent served as the control. The experiments were repeated as described above, with the concentration of detergent increased and the oxygen utilization rate recorded. Eight concentrations were tested for each detergent followed by replicate runs of three concentrations. The concentrations selected for replication were selected to cover the range of concentrations tested for each specific detergent.

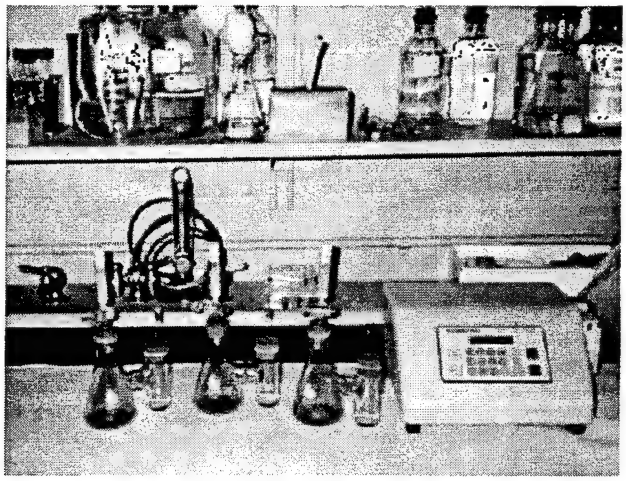
Several problems were encountered when testing some of the detergents. At higher concentrations, several detergents did not completely solubilize. This lack of solubilization caused interferences with the operation of the oxygen probe. Attempts made to overcome the problems with each of these

Table 2. Problems Encountered During Phase I Testing and Attempted Solutions.

Detergent #	Name	Problem	Solution
8	MSI 8700	Detergent exceeded solubility causing interferences with the operation of the oxygen probe.	Reran detergent at lower concentrations. Data presented on data sheets as 8B.
12	815 QR	Detergent exceeded solubility causing interferences with the operation of the oxygen probe.	Reran detergent at lower concentrations. Data presented on data sheets as 12B.
13	AQUA #1	Detergent exceeded solubility causing interferences with the operation of the oxygen probe.	Reran with increased mixing speeds and at room temperature.
20	PF Degreaser	PF Degreaser was insoluble in water and could not generate accurate data.	Could not perform respiration test on this detergent.

detergents are summarized in Table 2. The problem encountered with the PF Degreaser being insoluble and lighter than water could not be overcome. Because obtaining accurate respiration data for this detergent was not possible, the PF Degreaser was automatically included in the biodegradation potential study conducted in Phase II.

6.2 Phase II: Biodegradation Potential Study



Batch flask studies were conducted to determine the biodegradation potentials of all 20 detergents regardless of the respiration results obtained in Phase I. Detergents that exhibited severe inhibition at low concentrations were to be excluded from this test unless other important factors such as excellent cleaning characteristics warranted their use for cleaning processes. To select the two detergents for testing in Phase III, the biodegradation potentials were coupled with the results from Phase I. However, none of the detergents were so highly inhibitory as to be excluded from Phase II.

Conducting biodegradation experiments required collection of an adequate volume of activated sludge samples from the Heath WWTP to set up a complete set of experimental flasks. Samples were collected in ½-gallon Nalgene™ containers that were placed on ice in insulated coolers and transported to the laboratory at Battelle. The samples were refrigerated at 4°C upon arrival at the laboratory.

Microbial cultures used for examining detergent degradation were set up in specially designed biometer flasks, as shown in Figure 2. These flasks are specially designed to trap any CO_2 evolved as a result of microbial respiration. In addition to measuring the amount of CO_2 evolved, total solids (TS), and volatile solids (VS), and soluble COD were measured in the culture broth prior to and following incubation. The evolved CO_2, VS, and soluble COD were measured both in the cultures that received detergent and in the control cultures. Assaying for these parameters made it possible to

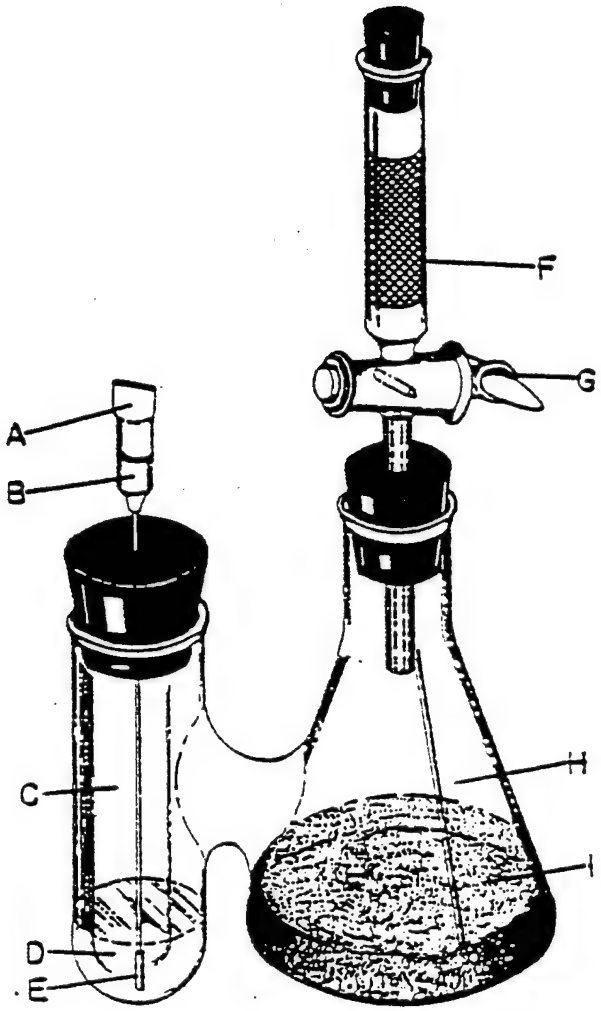


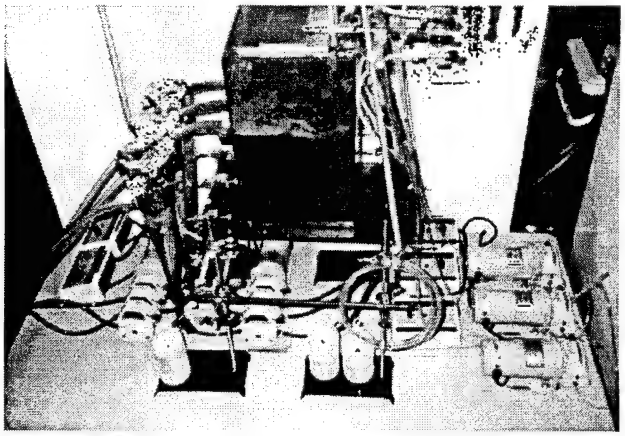
Figure 2. Biometer Flask For Measuring CO_2 Production. A = Rubber Closure, B = Syringe Needle, C= Side-Arm, D = Alkali, E = Guard, F = Ascarite, G = Stopcock, H = Sample Compartment, I = Sample (Atlas and Bartha, 1981).

categorize the detergents according to their potential fate in the WWTP.

In each biodegradation experiment, 10 mL of activated sludge was added to each of nine biometer flasks. Three flasks served as sterile controls, three served as nonamended controls, and three served as triplicate degradation cultures; each received the same amount of detergent.

Detergent was added to the flasks at a concentration equal to or below the inhibition threshold concentration that caused an inhibitory effect as determined in Phase I. The side arms of the biometer flasks were filled with an alkaline CO_2 trapping solution, potassium hydroxide (KOH). The flasks were closed, placed on an orbital environmental shaker table, and rotated at 150 rpm at 25°C for 28 hours, equal to the hydraulic residence time at the Heath WWTP. At the end of 28 hours, the flasks were harvested and the CO_2 trapping solution was analyzed for CO_2 by titrating the KOH trapping solution with HCl. The CO_2 produced in control flasks without detergent was subtracted from the CO_2 produced in the degradation cultures. The culture liquid also was analyzed for solids and soluble COD. Total solids were determined by pipetting 3 to 5 mL into aluminum weighing pans. The pans were dried to constant weight at 105°C. After determining the total solids, the samples were ashed at 550°C for 1 hour. The pans could then be weighed. The soluble COD was determined by centrifuging 1.5 mL at 16,000 rpm for 10 minutes. One ml of supernatant was diluted 1:1 with high-purity Milli-Q™ water added to Hach COD reagent vials. The vials were refluxed for 2 hours, then cooled and analyzed spectrophotometrically.

6.3 Phase III: Bench-Scale Activated Sludge System Study



The bench-scale activated sludge system study was conducted to determine how introducing washwater from the cleaning operations at Newark AFB could impact the Heath WWTP. Two detergent washwater types were used for this study and included Formula 815 GD and Versaclean

solutions. Both solutions were collected from operational baths at Newark AFB and were provided to Battelle by the AGMC.

Three bench-scale activated sludge systems were constructed for this phase of the research. Figure 3 is a schematic representation of the process flow for the three systems. The settled primary used for the system influent was kept refrigerated at 4°C in Nalgene™ carboys. The water was pumped through the wall of the refrigerator into the aeration basin as shown in Figure 3. The water then flowed into a clarifier to separate the biomass (sludge) from the water, which then overflowed into a waste receptacle. The settled sludge was pumped from the bottom of the clarifier and either wasted to the waste receptacle or returned to the aeration basin. Air was passed through a water trap humidifier then through a flow control rotameter and into the aeration basin. Off-gasses were vented to the atmosphere.

The reactors were sized to both simulate the Heath WWTP and minimize the volume of feedwater required to keep the systems running (Figure 4). The aeration basins were designed with a lid to prevent excess splattering and potential foam over in the laboratory. Each reactor had three overflow ports incorporated into the back wall to serve as a safety outlets if the effluent ports were to clog. The lower section along the back of the reactor help prevent dead spaces and promote uniform rolling throughout the reactor water column. The clarifier was sized to approximate the residence time of the Heath WWTP.

The operating parameters were adjusted to simulate the Heath plant and included temperature (~25°C), hydraulic residence time (28 hours.), and mean cell residence time (6 days).

All three reactors were started and brought to equilibrium based on the COD of the effluent. Upon achievement of steady state, one aliquot of each washwater was introduced into one of the reactors and the third reactor served as a no-detergent control. The COD of the effluent was then monitored until the systems returned to steady state.

An initial experiment was conducted by injecting 3.8 mL of each of the washwaters into each reactor, respectively, to achieve an initial concentration of 0.1% (vol/vol). Although this detergent loading was determined to be higher than a worst case scenario that the Heath plant could experience, it was calculated to be the minimal concentration at which the COD could be monitored. Due to the rapid removal of the COD during this first experiment, the COD values were too low to accurately measure, with the differences between reactors being within the scatter of replicate COD analyses. To be able to monitor the COD, the next experimental run was conducted by injecting 10 mL of washwater into the reactors. This resulted in an initial washwater concentration of 0.25%, much

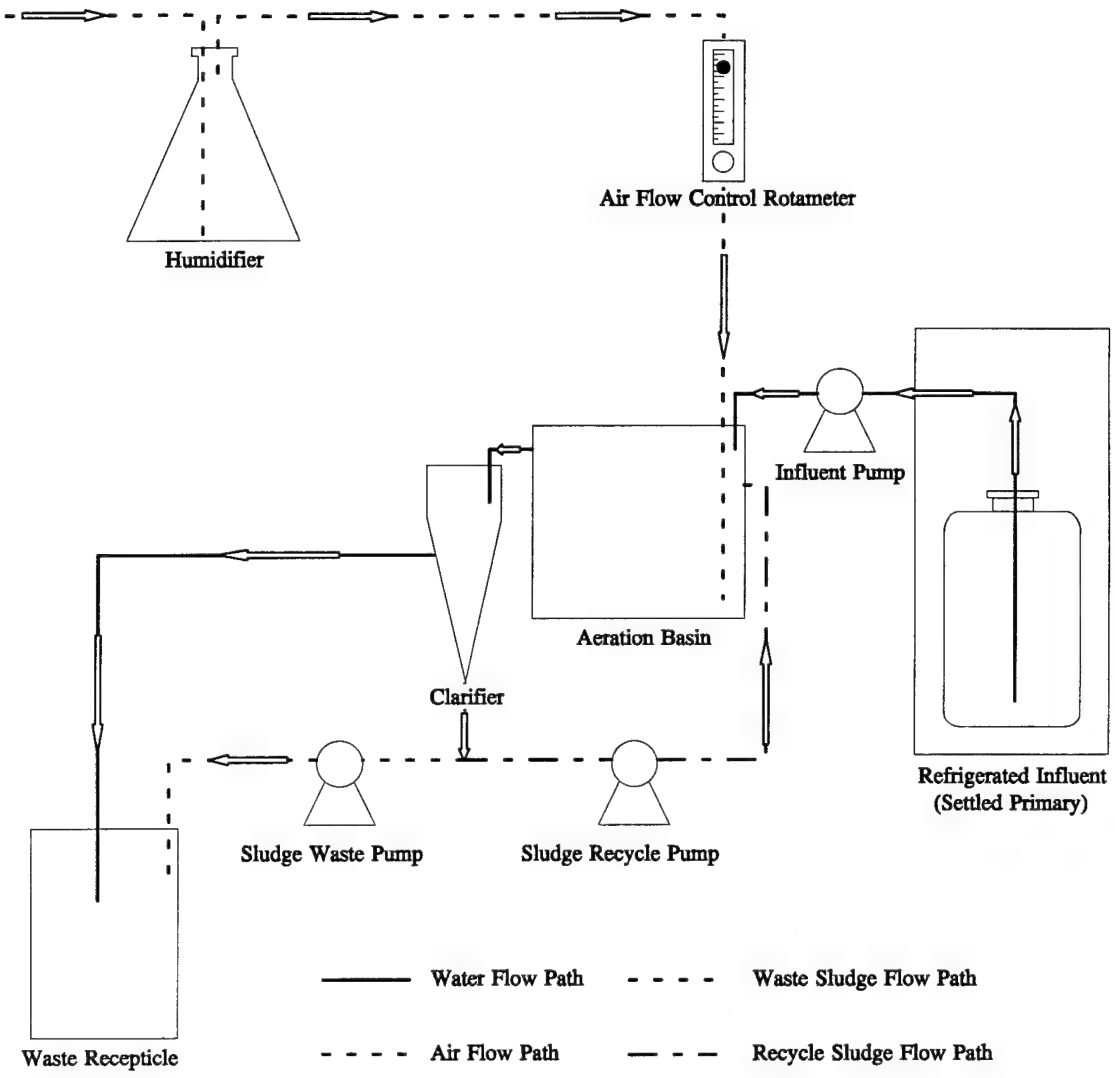


Figure 3. Schematic of the Bench-Scale Activated Sludge Process Train Used in Phase III of the Detergent Biodegradation Study.

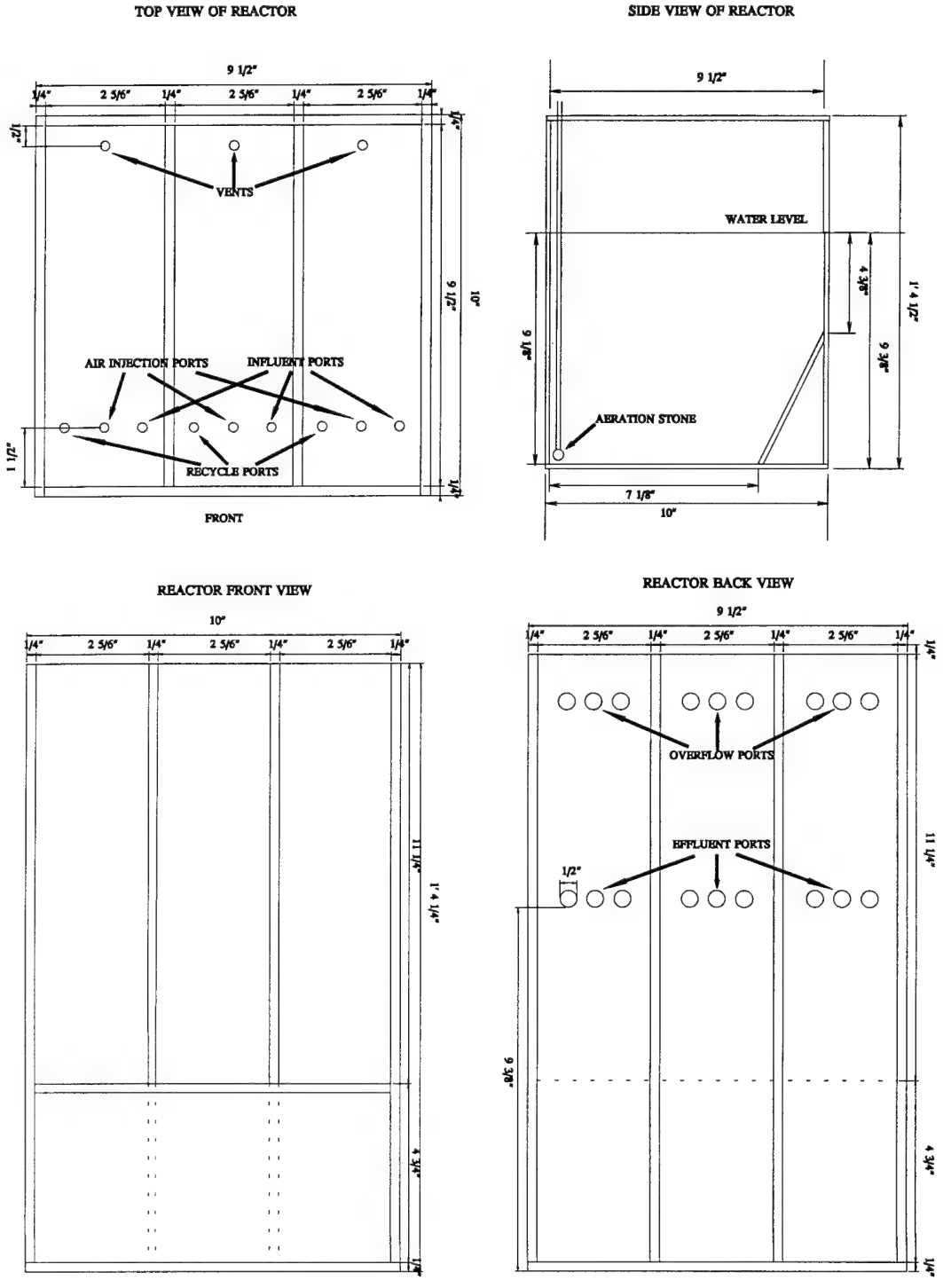


Figure 4. Design of the Activated Sludge Aeration Basin Used in Phase III of the Detergent Biodegradation Study.

greater that could be expected at Heath. At the detergent loading, the COD concentration was high enough to allow for monitoring the COD removal capability of the system.

After the reactor systems returned to preinjection status, the experiment was repeated at the 0.25% washwater concentration. It was originally planned to follow this run with a run at a washwater concentration that would cause a serious impact on the COD removal performance of the activated sludge systems. However, conducting an experimental run at washwater concentrations above 0.25% was not possible because of the foaming problems that resulted at this concentration. If the washwater concentration were increased above this level, the reactors would have experienced foamout, which would have both resulted in the removal of a large percentage of the culture and caused difficulties in system evaluation. In lieu of the foaming problems, a third experimental run was conducted at the 0.25% washwater concentration.

The reactors were monitored by measuring the COD, solids, and oxygen utilization rates in each reactor. COD analyses were conducted by withdrawing 10 mL of sample from each reactor and filtering the samples. Two mL of the filtrate was injected into a Hach COD reagent tube, then digested for 2 hours. After the COD tubes cooled to room temperature, the COD values were determined spectrophotometrically. The values from the spectrophotometer were recorded and the COD concentrations were calculated using the appropriate dilution corrections.

7.0 RESULTS AND DISCUSSION

7.1 Phase I: Respiration Rate Study

All data generated during the Phase I experiments are provided in tabular form in Appendix A. The tables in Appendix A contain the oxygen utilization rates for the "blank" cultures (activated sludge without detergent) and the amended cultures (activated sludge with detergent added at the noted concentrations). The percent change is the difference between the oxygen utilization rates in the two cultures. A positive value indicates inhibition, whereas a negative result suggests that the lower concentrations of some detergents actually stimulated microbial respiration.

Figure 5 shows the percent changes in the oxygen utilization rates as a function of detergent concentration on a percentage basis (vol/vol). The values were calculated as the difference in the oxygen utilization rates between cultures receiving detergent and control cultures not receiving

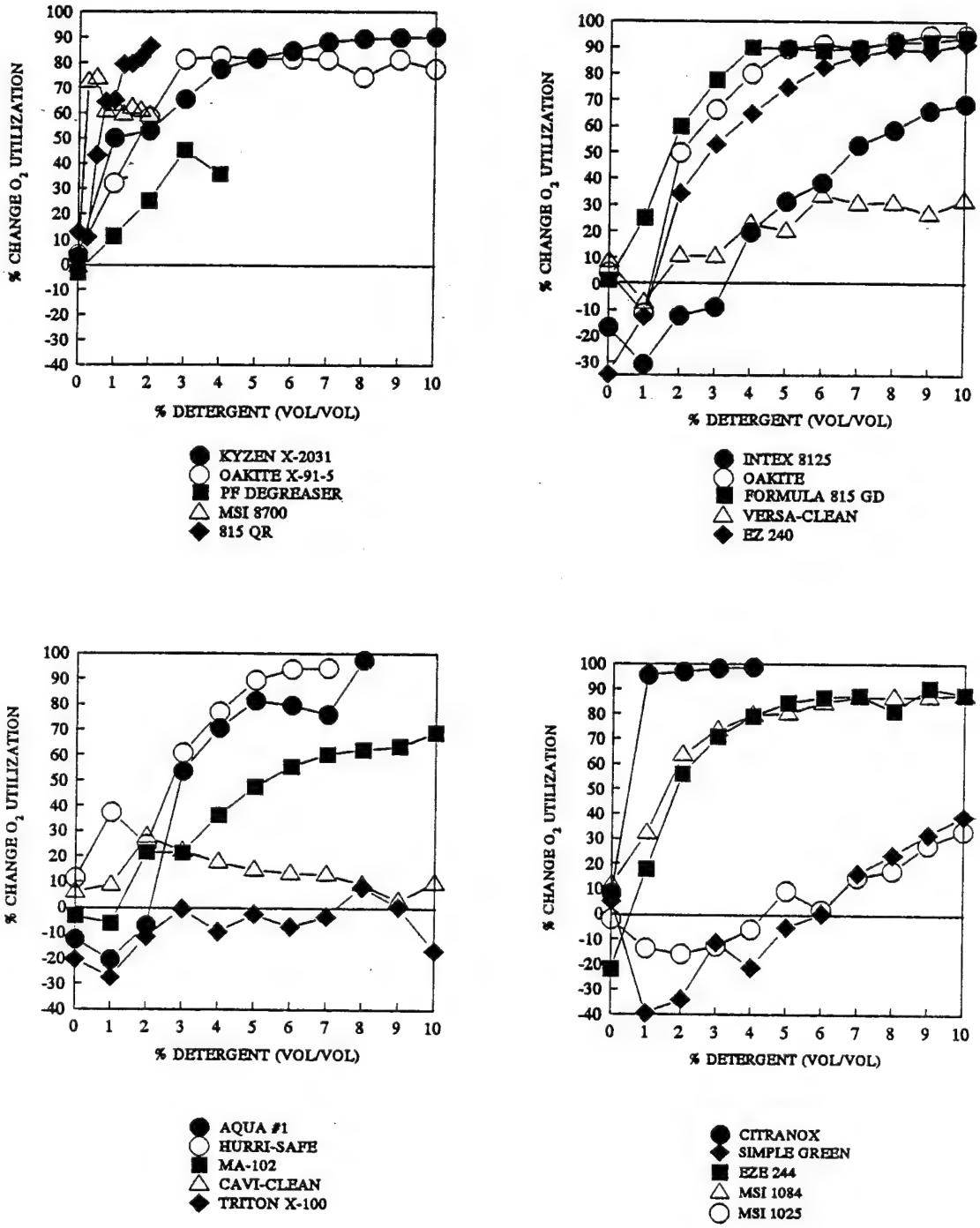


Figure 5. Oxygen Utilization Curves as a Function of Detergent Concentration.

detergent additions. The data presented in Figure 5 show that, based on the inhibitory responses, there were three basic groupings of the detergents. The highly inhibitory detergents produced greater than 60% inhibition in the respiration rate at concentrations below 2%; addition of medium inhibitory detergents resulted in 60% inhibition at concentrations between 2 and 6%; and the slightly inhibitory detergents reduced respiration by less than 60% at concentrations above 6%.

The plotted data show that many of the lesser inhibitory detergents caused an increase in respiration rates when added at the lower concentrations. The increases indicate that the activated sludge cultures were degrading the detergents and using them as a substrate. This phenomenon was further investigated in the biodegradation potential studies in Phase II.

A common parameter for quantifying the toxicity of a compound is referred to as the chemical's EC_{50}. The normal definition of EC_{50} is the concentration of chemical at which 50% of a test population is killed in a given amount of time. For the purpose of this study, EC_{50} is defined as the detergent concentrations at which the respiration rates for the activated sludge cultures are reduced by 50%. Although the EC_{50} parameter was selected to screen the detergents for further testing in Phases II and III of this study, the resulting values provide some useful information for determining potential impacts that the detergents might have on the Heath WWTP.

The EC_{50} values were extrapolated from Figure 5 to rank the detergents in order of decreasing inhibition potential. The ranking along with the extrapolated EC_{50} values are presented in Table 3. The detergents are listed in descending order of inhibition potential, based on these EC_{50} values. The EC_{50} values ranged from 0.3% to 6.8% for Ultraclean 8700 and Intex 8125, respectively.

The increases in oxygen utilization rates observed for several of the detergents indicate that, at lower detergent concentrations, the detergent may have served as a substrate for the activated sludge culture. The Phase I experiments were not set up to determine if the detergents were biodegraded by the cultures but only to measure a change in the respiration rates between cultures that did and did not receive detergent additions. The results from the experiments conducted in Phase II were designed to determine the biodegradation potential of the detergents. These results are discussed in Section 7.2.

The significance of the EC_{50} values becomes apparent when put into perspective with potential detergent concentrations that might be realized at the Heath WWTP as a result of discharge from Newark AFB. To achieve a 0.25% concentration in the aeration basin at Heath, Newark AFB would need to discharge approximately 3,000 gallons of concentrated (100%) detergent. The

Table 3. Ranking of the 20 Detergents Based on the EC_{50} Values Determined from Their Inhibition of the Respiration of Activated Sludge Cultures From the Heath WWTP.

Detergent	EC_{50}
Ultraclean 8700	0.3
Citranox	0.5
815 QR	0.6
Kyzen X-2031	1.0
MSI 1084	1.5
Formula 815 GD	1.7
EZE 244	1.8
Oakite X-91-5	1.8
Oakite	2.0
Hurri-Safe	2.7
EZE 240	2.9
Aqua #1	2.9
MA-102	5.3
Intex 8125	6.8
Versaclean	> 10*
Cavi-Clean	> 10*
Simple Green	> 10*
MSI 1025	> 10*
Triton X-100	> 10*
PF Degreaser**	ND

* 10% was the maximum concentration tested due to solubility, foaming, and probe interference problems. Because 50% inhibition was not observed at any of the concentrations up to 10%, it was assumed that the EC_{50} was greater than 10%.

** Unable to accurately examine inhibition relative to detergent concentrations due to its low solubility in water.

discharged detergent would have to enter the WWTP as an instantaneous slug. The full-service plan for Newark AFB is to operate up to 16 washing systems, with each one using approximately 5 gallons of a 5% detergent solution. If all 16 baths were discharged simultaneously to the sewer system and if the detergent wash solution were to enter the Heath plant as a slug, the resulting concentration would be 0.0003%. This concentration is only approximately 0.12% of the EC_{50} of the most inhibitory detergent, Ultraclean 8700. This percentage suggests that under a worst case scenario, any contribution of detergent from Newark AFB to the Heath WWTP would have no noticeable impact on the respiration of the activated sludge microorganisms.

7.2 Phase II: Biodegradation Potential Study

The CO_2, COD, and VS data generated from the biodegradation potential studies have been tabulated and are included in Appendices B. The values reported in these tables are the differences between measured values for initial and final (after 28 hours incubation) cultures that either received detergent or did not have detergent added. The results from these analyses provide useful insight into the potential fate of the detergents if discharged to the Heath WWTP. Possible pathways for the detergents in the WWTP include biosorption, biodegradation, physical/chemical breakdown, foamout, or discharge to the effluent. The desired pathway for any organic entering a WWTP is biodegradation through which the detergents would be converted to CO_2 and biomass. The two undesirable pathways include foamout and discharge. Excess foaming in the aeration basin could lead to problems associated with removal of the activated sludge organisms with the foam as well as other associated operational problems. Discharge in the effluent would contribute a load to the discharge parameters including both biochemcial oxygen demand (BOD) and COD, solids (dissolved), and potentially toxicity.

The data for the COD, CO_2, and solids analyses were reduced and the results are summarized in Tables 4, 5, and 6, respectively. The data in these tables indicate that there were few detergents that could be easily classified as a defined percent biodegradable due to variations in data trends data based on the measured values for all three parameters. Under optimum conditions, this type of detergent would be characterized by a decrease in COD and an increase in CO_2 and solids production. However, six different trends emerged for the 20 detergents tested. The data trends are categorized and described in Table 7. The detergents are classified according to data trend category in Table 8.

Table 4. Average Soluble COD From Triplicate Flasks After 28 Hours Incubation.

Detergent	Initial Detergent COD (mg/L)	Final Detergent COD (mg/L)	Initial - Final (mg/L)
Intex 8125	1996.8	937.0	1059.8
Oakite	2650.6	1000.0	1650.6
Formula 815 GD	1468.0	1555.3	-87.3
Versaclean	1749.5	411.0	1338.5
EZE 240	3614.4	1380.7	2233.7
Citranox	2244.0	941.4	1302.6
MSI 1025	2597.3	820.0	1777.3
Ultraclean 8700	1766.6	3001.3	-1234.7
EZE 244	5324.0	698.7	4625.3
Intex 8284	873.3	473.3	400.0
Simple Green	1329.7	265.7	1063.8
815 QR	1754.7	330.0	1424.7
Aqua #1	3041.0	963.3	2077.7
Hurri-Safe	6721.0	3258.0	3463.0
MA-102	2554.7	1886.0	668.7
Cavi-Clean	1125.5	895.0	230.5
Triton X-100	20094.7	4931.3	15163.4
Kyzen X-20-11	14221.0	1391.3	12829.7
Oakite X-91-5	2200.0	321.3	1878.7
PF Degreaser	200.0	173.3	26.7

Table 5. Carbon Dioxide Production by Activated Sludge Cultures Following the Addition of Each of 20 Detergents.

Detergent	Detergent CO_2	Blank CO_2	Detergent CO_2 - Blank CO_2
Simple Green	28.9	34.5	-5.6
Intex 8125	36.3	34.5	1.8
Cavi-Clean	41.3	34.5	6.8
Versaclean	37.0	34.5	2.5
Oakite	35.3	36.5	-1.2
Citranox	36.2	36.5	-0.3
MSI 1025	37.1	36.5	0.6
EZE 244	36.1	36.5	-0.4
Hurri-Safe	34.0	35.4	-1.4
Aqua #1	35.1	35.4	-0.3
EZE 240	35.2	35.4	-0.2
Kyzen X-20-11	35.7	35.4	0.3
Ultraclean 8700	35.6	35.1	0.5
Intex 8284	34.8	35.1	-0.3
Oakite X-91-5	35.2	35.1	0.1
PF Degreaser	35.0	35.1	-0.1
Formula 815 GD	36.3	36.1	0.2
815 QR	33.3	36.1	-2.8
MA-102	35.1	36.1	-1.0
Triton X-100	36.7	36.1	0.6

Table 6. Solids Data After 28 Hours of Incubation Following the Addition of Detergent. (Values presented are the differences between the initial and final values for cultures that did and did not receive detergent.)

Detergent	Total Solids (mg/L)	Volatile Solids (mg/L)
Intex 8125	-1001.7	-570.4
Oakite	302.9	49.9
Formula 815 GD	392.2	-4.1
Versaclean	-672.0	-454.4
EZE 240	-2556.7	-957.6
Citranox	702.5	9.0
MSI 1025	552.2	204.9
Ultraclean 8700	2462.0	1828.6
EZE 244	535.1	-106.3
Intex 8284	-1673.3	-23.1
Simple Green	-399.9	-397.1
815 QR	417.7	7.8
Aqua #1	-2960.6	-985.5
Hurri-Safe	-2705.5	-1072.5
MA-102	2897.9	416.7
Cavi-Clean	-248.2	-307.4
Triton X-100	9078.4	-53.8
Kyzen X-20-11	3929.7	993.6
Oakite X-91-5	2153.9	511.8
PF Degreaser	-23.5	177.5

Table 7. Detergent Categories Based on the Resulting Trends in COD, CO_2, and Volatile Solids Data Generated in Phase II.

Category	Description
Category 1	Characterized by a decrease in COD, a net increase CO_2 production, and a net increase in volatile solids production
Category 2	Characterized by a decrease in COD, a net decrease in CO_2 production, and a net increase in volatile solids production
Category 3	Characterized by a decrease in COD, a net decrease in CO_2 production, and a net decrease in volatile solids production
Category 4	Characterized by an increase in COD, a net increase in CO_2 production, and a net decrease in volatile solids production
Category 5	Characterized by an increase in COD, a net decrease in CO_2 production, and a net decrease in volatile solids production
Category 6	Characterized by a decrease in COD, a net increase in CO_2 production, and a net decrease in volatile solids production
Category 7	Characterized by an increase in COD, a net increase in CO_2 production, and a net increase in volatile solids production

Table 8. Categorization of Detergents Based on the Resulting Trends in COD, CO_2, and Solids Data Generated in Phase II.

Detergent Categorization	
Category 1	MSI 1025
	Kyzen X-20-11
	Oakite X-91-5
Category 2	Oakite
	Citranox
	PF Degreaser
	815 QR
	MA-102
Category 3	EZE 244
	Hurri Safe
	Aqua #1
	EZE 240
	Intex 8284
	Simple Green
Category 4	None
Category 5	Formula 815 GD
Category 6	Intex 8125
	Cavi Clean
	Versaclean
	Triton X-100
Category 7	Ultraclean 8700

The data trends for each of the categories reflected a different scenario when the activated sludge cultures were exposed to each of the 20 detergents. Brief discussions of possible explanations for and the significance of each of the data trends for each category are presented below.

Before presenting possible explanations for the data trends, it is necessary to describe the potential effects that the detergents may have on the cultures and how these effects would impact the measured values of the COD, CO_2, and solids. The addition of any of the 20 detergents will cause an immediate increase in the COD and solids concentrations in all cases. The detergent can then cause an additional increase in the COD by causing lysis of the activated sludge organisms. When the cells lyse, the intercellular components are released into solution. These components are soluble and would show up in the COD analysis. If the culture is not completely wiped out, and the detergent is biodegradable, the surviving cells would utilize the COD as a substrate and produce CO_2 and solids. The COD also can be reduced by adsorption of the detergent by the biomass. During sample processing for the COD analysis, any detergent that is adsorbed will be removed.

Adding detergent to a biological culture can affect the solids concentration in two ways. As mentioned above, the detergent can contribute to the measured solids and cause an immediate increase in the measured value. Detergents also can cause a decrease in the solids content by disrupting the cell walls of the bacteria. However, it is doubtful that the addition of detergent to a culture would cause a net decrease in the total solids concentration simply due to the dissolution of the cell walls.

As shown in Phase I, the inhibition of the activated sludge cultures and the decrease in respiration rates were dependent on the concentration of the detergents. In the Phase II experiments, the 0.5% concentration was below the EC_{50} for most of the detergents but remained in the inhibitory range. The Phase II experiments were conducted over a 28-hour time period that may have been long enough to allow the activated sludge cultures to acclimate to the detergent and respire at a rate equal to, or even greater than, that observed in Phase I. These experiments were conducted to compare the respiration rates, COD removal, and solids formation between cultures that received detergent and control cultures that did not receive detergent. The objective was to determine the biodegradability of each detergent to predict its potential fate in the Heath WWTP.

The test was conducted for 28 hours to simulate the hydraulic residence time at the Heath WWTP. Cultures that respired at a lower rate when detergent was added resulted in a negative CO_2 production and were determined to be inhibited. Detergents that increased respiration and resulted in a positive CO_2 production were determined to be biodegradable.

Depending on the impact of the detergent on the culture, the ability of the culture to recover and degrade the detergent, the resulting values for the COD removed, the amount of CO_2 produced, and the amount of solids formed would be greater or less than the values in the control cultures that did not receive any detergent. The following discussions explain these results on a category basis.

The data trend described for Category 1 is what would be expected from a batch culture that is neither limited in nutrients, nor inhibited to any appreciable extent by either the added detergent or any other metabolic byproduct. The net effect of adding the detergent was that it did not inhibit the culture to any appreciable extent and that it served as a growth substrate and was degraded resulting in the evolution of CO_2 and production of biomass. Although there were three detergents fitting Category 1, it was not possible to construct a mass balance for any of them. The analytics included in this study did not account for the amount of detergent adsorbed vs. the amount degraded. Although CO_2 evolution is a measure of the mineralization of organic compounds, it did not effectively reflect the fraction of detergent that was degraded in these experiments. However, it is certain that the detergents in Category 1 were biodegradable to some extent. Table 9 contains the percent biodegradability of the detergents based on the fraction of the COD contributed by the detergent that was removed over the 28-hour incubation period.

Category 2 data suggest that the detergent may have been adsorbed to the biomass and that the detergent was inhibitory to the cultures. Typically, a reduction in COD and increase in solids concentration would be indicative of biodegradation. However, when coupled with a decrease in CO_2 production, reduction in COD suggests that the detergent being adsorbed to the biomass is responsible for the removal of soluble COD, with the material showing up in the solids analysis. The decrease in CO_2 produced in the cultures that received detergent suggests that respiration was affected by the detergent. Determining the amount of detergent adsorbed vs. the amount degraded was not possible using the data obtained in these experiments. An alternative explanation would be that the cultures were able to degrade the fraction of the detergent that resulted in the reduced COD, and that new cell mass was formed in disproportion to the amount of CO_2 evolved. This scenario does not make sense from a biological standpoint and would be difficult to support based on the data obtained. It is probable that the cultures were able to degrade some fraction of the detergent, but the CO_2 data indicate some degree of inhibition suggesting that adsorption played a significant role in the observed changes in COD and solids values.

Category 3 contains detergents characterized by a net decrease in all three parameters. This trend suggests that the detergents inhibited the respiration of the cultures and may

Table 9. Detergent Biodegradabilities Based on the Amount of COD Removed by Activated Sludge Cultures From the Heath WWTP Over a 28-Hour Period.

Detergent Biodegradability Study	
Detergent	**Biodegradability (%)**
Simple Green	80.0
Intex 8125	53.1
Cavi Clean	20.5
Versaclean	76.5
Hurri Safe	51.5
Aqua #1	68.3
EZE 240	61.8
Kyzen X-20-11	90.2
Formula 815 GD	-5.9
815 QR	81.2
MA 102	26.2
Triton X-100	75.5
Ultraclean	-69.9
Intex 8284	45.8
Oakite X-91-5	85.4
PF Degreaser	13.3
Oakite	62.3
Citranox	58.1
MSI 1025	68.4
EZE 244	81.9

have lysed some of the cells accounting for some of the decrease in the solids concentration. The decrease in COD concentration indicates that detergent was removed from solution. Coupling the decrease in COD with a decrease in solids suggests both cell lyses and adsorption are the more prominent mechanisms. Although a significant number of cells may have lysed, the net reduction in COD is possible because of the mass ratio between carbon (MW 14) in the volatile solids analysis compared to the mass of oxygen (MW 32) in the COD analysis. For example, a reduction of 10 mg/L of COD would result from a decrease of 4.38 mg/L of carbon.

Detergents that would have fallen into Category 4 would have caused a significant amount of lysing and would not have been readily adsorbed. The cultures would have to remain viable and be respiring at a higher rate than the control cultures, even though they were significantly impacted by the detergents. Fortunately, none of the detergents fell into this category, because this trend would be extremely difficult to explain.

Category 5 contains the one detergent that was inhibitory to the activated sludge organisms and caused a reduction in CO_2 production. The net increase in COD coupled with a net decrease in solids concentration suggests that this detergent also caused lyses of cells and was not adsorbed to any appreciable extent. Formula 815 GD was the only detergent that fit into this category. This detergent was contained in one of the washwaters examined in Phase III.

The data trend characterizing Category 6 indicates that the cultures are actively metabolizing the organics in the culture. The simultaneous reductions in COD and solids can be indicative of at least two scenarios. The first scenario involves both the biodegradation of the detergent and the lysing of cells. Although the lysed cells would release intercellular components into the liquid and cause an initial increase in COD, the cellular materials are usually readily taken up by surviving cells and used in their metabolism. Following the original disturbance of the culture due to the detergent addition, the culture would begin to degrade the detergent. Maintaining a mass balance means that, because the solids concentration decreased over the 28-hour period, more cells would have lysed than formed over this time.

The second scenario for Category 6 includes the biodegradation of the detergent and endogenous decay of the culture. The decrease in solids over the 28-hour period does not necessarily mean that the cells have lysed. The activated sludge cultures used in these experiments were obtained from the return line at the Heath WWTP. These cells have been retained for some period in a nutrient-deficient condition. Depending on the biodegradability of the detergent, the culture may have utilized all of the available substrate (detergent and background organics) and subsequently have gone

into endogenous decay. Endogenous decay is the process by which a microbial population begins to decline. Some cells lyse, and others live on the materials released from the dying cells. Under optimal conditions, activated sludge systems function to bring the cells close to this point. It is conceivable that the cultures degraded the readily biodegradable fraction of the detergent that was added and went into endogenous decay over the 28-hour incubation period.

Category 7, which results in an increase in all three parameters, is difficult to explain. The implication from this trend in the data suggests that the culture is both releasing soluble COD at the same time solids (biomass) are being formed. This could occur if the cultures were photosynthetic or were in some way capable of fixing inorganic carbon. This is not believed to be the case with activated sludge cultures, and the fact that testing Ultraclean 8700 resulted in a Category 7 most probably is due to experimental "error." As previously mentioned, the experiments were conducted at very low concentrations and used activated sludge as the source of culture. Because the culture itself is highly variable in COD and biomass concentration, it was possible that a small variation in any one of the measured parameters could have skewed the measurements and resulted in the trend shown for this detergent.

7.3 Phase III: Bench-Scale Activated Sludge System Study

The results from the first trial run of the bench-scale activated sludge system resulted in COD contributions that were below the detectable limits (data not shown). This run was conducted at an initial washwater concentration of 0.1% which was estimated to be a worst case scenario, but at the same time the minimum concentration for which we would be able to monitor COD. However, once injected into the aeration basin, the detergent concentrations in the washwater samples were too low to be able to detect the COD. The detergent concentration was then increased to 0.25% and the experiments were repeated three times. The results from the triplicate runs were combined and are presented below.

Shown in Figure 6 is the average soluble COD in the effluent from the activated sludge reactor. The amount of COD added to the reactors was 138.9 mg (34.7 mg/L) and 39.9 mg (10.0 mg/L) for the Formula 815 GD and Versaclean washwaters, respectively. Immediately following detergent injection, 50.4% of the Formula 815 GD and 100% of the Versaclean COD was measured in the reactor effluent. Within 1 hour, the COD was being removed for both washwater types. By the third hour, the COD in the reactor receiving Versaclean had decreased to preinjection levels. The COD in the reactor that

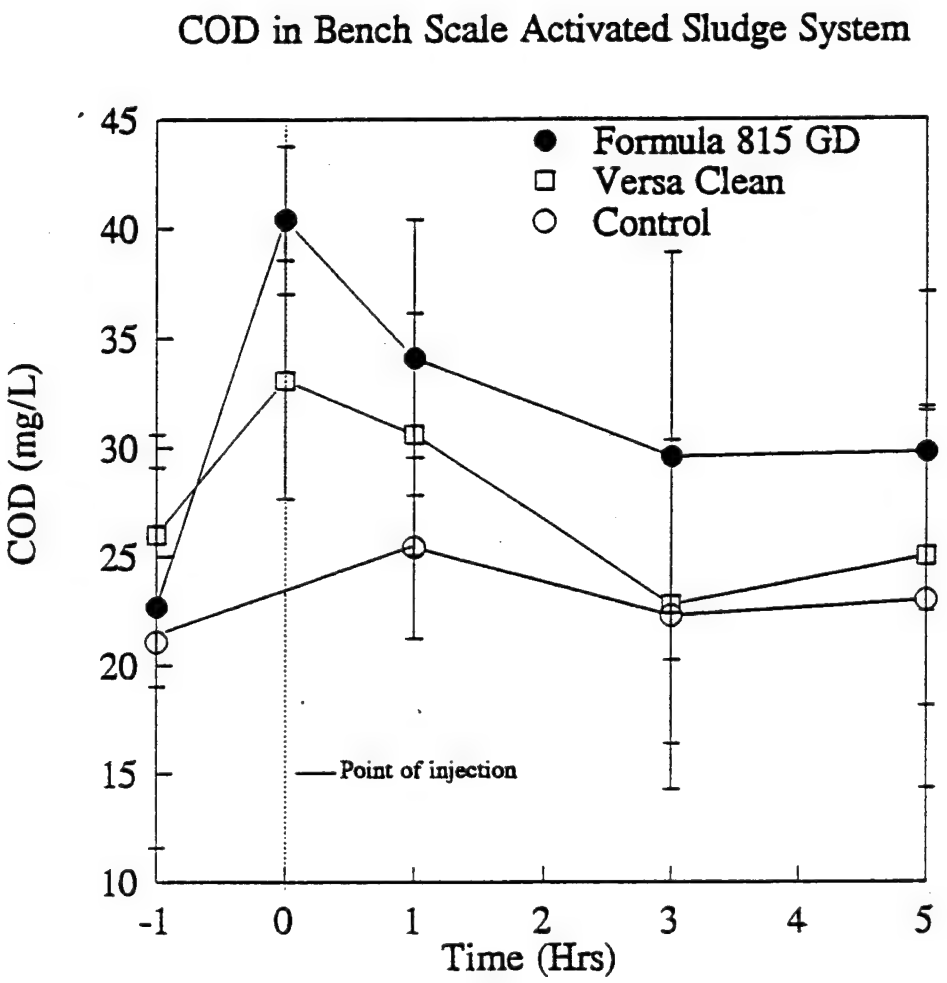


Figure 6. Average COD Profiles Over Time of Reactor Effluent from Triplicate Experiments.

received Formula 815 GD leveled off after 3 hours with 20% of the initial COD remaining. This 20% of the Formula 815 GD COD could show up in the effluent from the Heath WWTP.

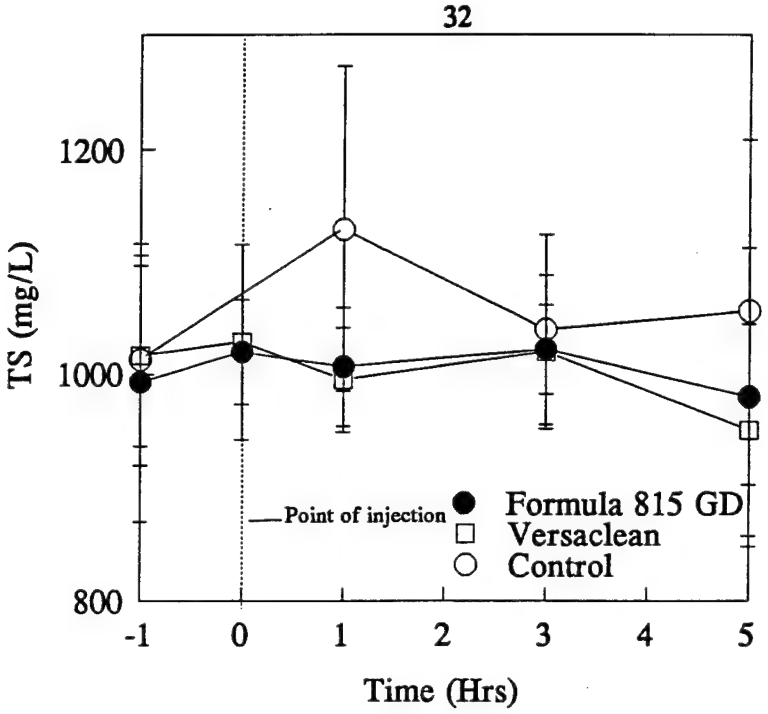
The main point of concern involving the COD contributions from the detergents are how they would impact the discharge levels of COD (BOD) from the Heath WWTP. The initial concentrations for both washwater types used in these bench-scale experiments were much higher (approximately 38 times) than could be expected under a worst case scenario. Based on this type of scenario, the maximum amount of COD that Newark AFB would contribute from detergent discharges would be 80 gallons (16 baths times 5 gallons each) of 13,887 mg/L or 3,987 mg/L solution if Formula 815 GD or Versaclean were the sole detergent, respectively. This quantity of an instantaneous input would result in an increase of 0.82 and 0.24 mg/L in the aeration basin at the Heath WWTP for the Formula 815 GD and Versaclean, respectively. If 80% of the COD from the Formula 815 GD were removed by the activated sludge organisms, the potential COD contribution to the discharge from the Heath WWTP would be approximately 0.16 mg/L. The COD contribution to the Heath WWTP from a discharge of Versaclean would be completely removed by the activated sludge bacteria.

Based both on these calculations and the potential for the worst case scenario, it is determined that discharging Formula 815 GD or Versaclean would cause no significant impact on the effluent concentrations of COD or BOD in the discharge from the Heath WWTP.

Another concern associated with any contribution to a municipal WWTP is the impact on solids. This includes both the formation of sludge and the discharge of dissolved solids. Figures 7a and b are graphical representations of the total and volatile solids data, respectively. Figure 7a shows that the total solids increases only slightly following detergent addition.

Figure 7b shows that the changes in the volatile fraction are within the scatter of the data between the triplicate experiments. This suggests that there was no measurable contribution to the volatile solids concentration in the reactor under the conditions of the experiment.

The third variable monitored during this phase of the study was the oxygen utilization rate as a function of time following detergent addition. Figure 8 shows how these rates were affected compared to the rate in the control reactor. Both washwater types decrease the oxygen utilization rate by approximately 33% after the first hour. The rate remained at this depressed level through the first 5 hours of monitoring. The levels returned to their initial level within 48 hours following detergent injection. The trend in decreases of oxygen utilization rates was consistent between the triplicate experiments.



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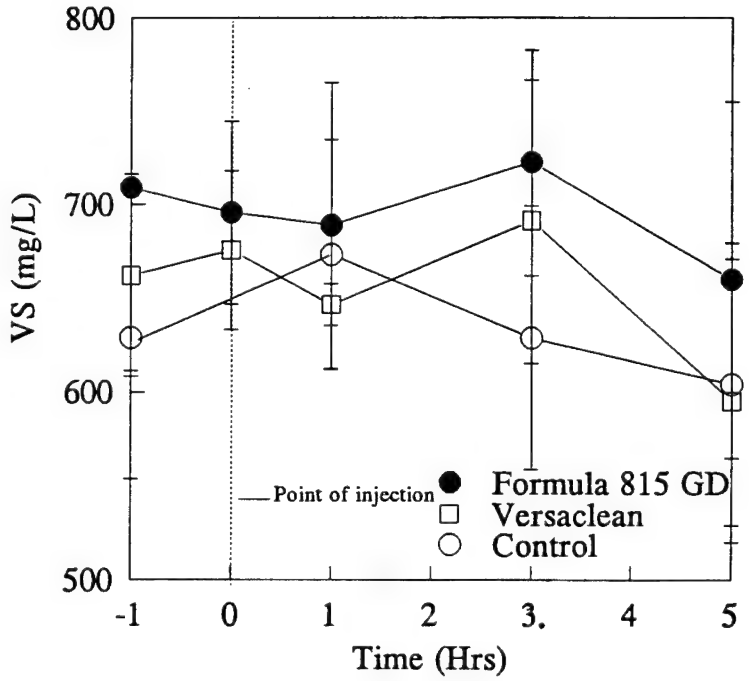

B

Figure 7. Average Solids Data from Triplicate Experiments. a. Total Solids, b. Volatile Solids.

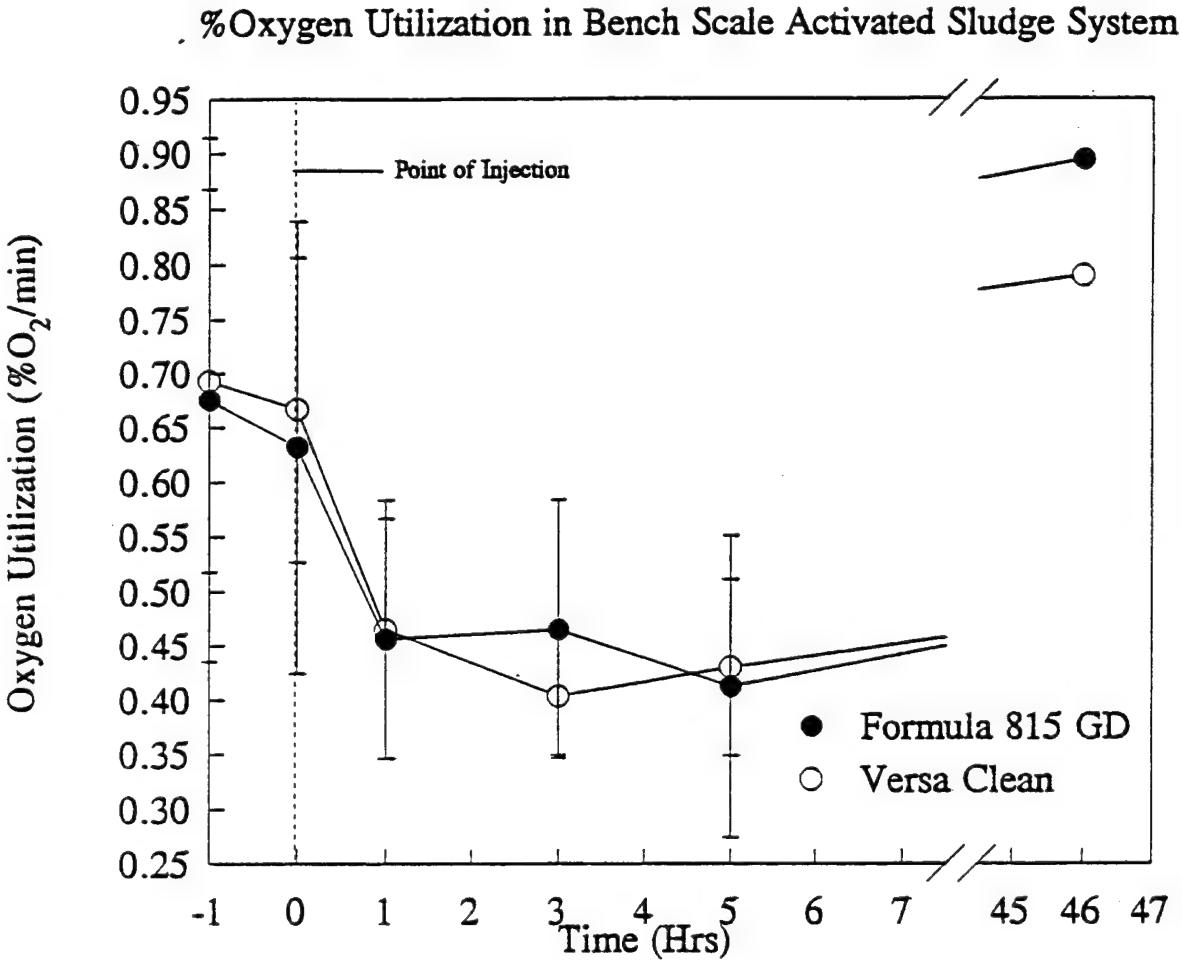

Figure 8. Average Oxygen Utilization Rate Profiles From Triplicate Experiments Conducted in Phase III.

Decreases in the rate at which the activated sludge organisms were utilizing oxygen were of more concern with the Formula 815 GD washwater than with the Versaclean washwater. This was because of the remaining fraction of the soluble COD in the effluent from the reactor system receiving Formula 815 GD washwater. The combination of these two observations suggests that there was a possible inhibitory effect that could have impacted the plant's performance. This effect was noticed at the extremely high concentration used for this study, and the reactor system did recover with in a 48-hour period. This coupled with the insignificant contribution of the detergent to the effluent COD indicates that, even under a worst case scenario, the effect of Formula 815 GD washwater would be insignificant.

8.0 CONCLUSIONS

Based on the findings from the three phases of this study and the results of the calculations performed to determine actual concentrations under a worst case scenario, the following conclusions are made regarding the discharge of the detergents included in this study from Newark AFB to the Heath WWTP:

1. All 20 detergents tested inhibited the metabolism of the activated sludge cultures from the Heath WWTP at a concentration much higher than could be expected at the plant even under a worst case scenario. The inhibition potential was dependent on the detergent. However, under normal operating procedures at Newark AFB, none of the detergents tests would cause any significant impact on the microbial population at Heath.

2. Evaluating biodegradation by using activated sludge cultures was difficult due to complex interactions between the detergents and the activated sludge cultures. Biodegradability of the detergents based on reductions in COD was a combination of biodegradation and biosorption. Although the measured values were not strictly biodegradability, the biodegradability fractions based on COD removal for the 20 detergents tested are valuable for assessing the potential of the activated sludge cultures from the Heath WWTP to remove the COD contributed by the detergents.

3. Although the detergents impacted the COD concentration in the effluent and the oxygen utilization rates in the bench-scale activated sludge reactors, the actual impacts on the Heath plant would be virtually unnoticeable. The detergent concentrations tested in this phase of the study were more than 40 times higher than a worst case scenario and the impacts observed in the bench-scale reactors were minimal. Of the small impact the detergents would have on the WWTP, the impact from Versaclean would be even less significant than that of the Formula 815 GD washwater.

4. Under normal operating conditions, the use and discharge of washwaters with any of the 20 detergents mixed in the same percentages as the two washwaters tested would contribute very little COD and TS to the discharge limits from Newark AFB.

9.0 RECOMMENDATIONS

The results from this study have shown that all of the 20 detergents inhibited the respiration of the activated sludge organisms at some concentration. This would be of concern if there was the potential of achieving these concentrations at the plant due to the discharge of any of the detergents from Newark AFB. However, the evaluation of a worst case scenario has demonstrated that the potential for any noticeable impact from either washwater tested in this study on the Heath plant is minimal. Because of this, it is not recommended that any form of pretreatment be applied to the washwater prior to discharge from the AGMC. Providing for any form of pretreatment for such small quantities would be expensive and, based on the results for the Versaclean and Formula 815 GD washwaters, would not be required. If it is desired to further minimize any risk, the discharge of washwater from the various bath units at Newark AFB could be scheduled on a staggered basis.

The final recommendation concerns the potential contribution any washwater might have on the discharge limits for Newark AFB. Although the two washwaters tested in this study were high in COD and solids, the volumes that would be discharged (5 to 80 gallons) would represent an extremely small fraction of the total discharge volume from Newark AFB (approximately 90,000 gallons/day). This would result in a dilution factor between 1,125 to 18,000 times. The current discharge limits for Newark AFB are 300 mg/L for BOD_5 and 250 mg/L for total suspended solids (TSS). As mentioned in the text, the contributions to these parameters by the two washwater types tested would be minimal.

However, it is recommended that any additional washwaters be analyzed to determine their concentrations of the regulated discharge parameters. The potential contributions should be added to the current discharge concentrations from Newark AFB to ensure that the washwater could be discharged without exceeding the regulatory limits. It is recommended that the discharge of the washwaters be scheduled to not only avoid exceeding the discharge limitations but remain as far below the regulated concentrations as possible. Because the regulations are based on a 24-hour composite sample type, washwater discharge could be scheduled on a daily basis.

10.0 GLOSSARY OF TERMS

Activate Sludge Organisms - A population of microorganisms obtained from, and/or maintained in, an activated sludge wastewater treatment system.

Biochemical Oxygen Demand (BOD) - The amount of oxygen required for the biochemical degradation of organic material in wastewater as well as some inorganic materials such as sulfides, ferrous iron, and some forms of reduced nitrogen that also may be present in a wastewater.

Biomass - The total mass (dry weight) of all cellular materials including both viable and nonviable organisms.

Cell Lysis - The process through which the cell wall of a dying or dead organism is degraded by the enzymatic hydrolyses of peptidoglycans by lysosomes, and the intercellular components are released into solution.

Chemical Oxygen Demand (COD) - The amount of oxygen required to chemically oxidize the organic materials in wastewater under strong oxidizing conditions.

EC_{50} - The concentration of a material at which the respiration rate of the test culture is reduced by 50 %.

Hydraulic Residence Time - The length of time that the water is in the reactor system determined by dividing the total reactor system volume by the flow rate.

Inhibitory - Any material that causes a decrease in the activity of the activated sludge culture.

Mean Cell Residence Time - The amount of time that an average organism remains in the reactor system as controlled by the recycle-to-wasting ratio.

Milli-Q® Water - Trade name for Millipore Corporation's 18 MegOhm high-purity water.

Mineralization - The complete oxidation of organic materials in wastewater to form carbon dioxide and water.

Total Solids - The amount of materials in wastewater that remains after evaporation of the water at 105°C.

Volatile Solids - The fraction of total solids that vaporize at 550°C.

11.0 REFERENCES

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APPENDIX A

PHASE I. RESPIRATION RATE STUDY DATA

Appendix A
Phase I. Respiration Rate Study Data

The data contained in the following tables are the results from laboratory experiments conducted to examine the effect of the detergents on the respiration of activated sludge cultures obtained from the Heath WWTP. These data were used to calculate the data reported in the body of this report. The following sample calculation illustrates how the data were used to calculate the percent change in respiration for each resulting detergent concentration.

Equation:

$$\% \ Change \ in \ Respiration = \frac{OxygenUtilizationRate_{control} - OxygenUtilizationRate_{detergent}}{OxygenUtilizationRate_{control}} \ X \ 100$$

For Intex 8125, for example, the % change in respiration resulting from a detergent concentration of 7.4% was calculated as follows:

$$\% \ Change \ in \ Respiration = \frac{8.883 - 3.667}{8.883} \ X \ 100$$

$$\% \ Change \ in \ Respiration = 58.7$$

Note: A negative value in the % change in respiration is caused by the oxygen utilization rate in the cultures receiving detergent being greater than in the control cultures. See the text for a possible explanation for this result.

Respiration Data for INTEX 8125

3/2/93		%O_2 UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	INTEX 8125	% CHANGE
CONTROL	0.00	9.000	10.50	-16.67
50	0.99	10.50	13.75	-30.95
100	2.0	10.25	11.50	-12.20
150	2.9	11.50	12.50	-8.700
200	3.8	11.33	9.083	19.57
250	4.8	11.40	7.833	31.29
300	5.7	10.00	6.167	38.33
350	6.5	8.250	3.900	52.73
400	7.4	8.833	3.667	58.49
450	8.3	10.00	3.400	66.00
500	9.1	9.500	3.000	68.42
REPLICATES				
100	2.0	9.000	10.50	-16.67
250	4.8	9.000	6.750	25.00
450	8.3	9.875	3.333	66.25

Note: Each volume of detergent was injected into 5.0 mL of return activated sludge.

Respiration Data for OAKITE LIQUID #2

3/3/93		$\%O_2$ UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	OAKITE LIQ. #2	% CHANGE
CONTROL	0.00	17.50	16.75	4.290
50	0.99	14.83	16.50	-11.26
100	2.0	15.33	7.667	49.99
150	2.9	14.83	5.000	66.28
200	3.8	15.83	3.167	79.99
250	4.8	14.25	1.500	89.47
300	5.7	13.50	1.187	91.21
350	6.5	12.25	1.250	89.80
400	7.4	13.17	1.000	92.41
450	8.3	12.67	0.6667	94.74
500	9.1	12.67	0.6667	94.74
REPLICATES				
100	2.0	12.00	8.000	33.33
250	4.8	12.33	1.750	85.81
450	8.3	11.50	0.7500	93.48

Note: Each volume of detergent was injected into 5.0 mL of return activated sludge.

Respiration Data for FORMULA 815 GD

3/4/93		$\%O_2$ UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	FORMULA 815 GD	% CHANGE
CONTROL	0.00	12.50	12.33	1.360
50	.99	11.50	8.625	25.00
100	2.0	10.00	4.000	60.00
150	2.9	10.30	2.300	77.67
200	3.8	10.00	1.000	90.00
250	4.8	9.625	1.000	89.61
300	5.7	9.000	1.000	88.89
350	6.5	10.00	1.000	90.00
400	7.4	9.750	0.7500	92.31
450	8.3	9.833	0.7500	92.37
500	9.1	10.33	0.6250	93.35
REPLICATES				
100	2.0	14.00	3.500	75.00
250	4.8	8.750	1.000	88.57
450	8.3	8.500	0.500	94.12

Note: Each volume of detergent was injected into 5.0 mL of return activated sludge.

Respiration Data for Versaclean

3/5/93		$\%O_2$ UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	Versaclean	% CHANGE
CONTROL	0.00	22.00	21.00	4.550
50	0.99	22.00	18.00	18.18
100	2.0	21.00	14.83	29.38
150	2.9	13.67	12.50	8.560
200	3.8	13.50	9.667	28.39
250	4.8	13.00	8.833	32.05
300	5.7	11.75	4.667	60.28
350	6.5	10.50	5.000	52.38
400	7.4	10.33	6.333	38.69
450	8.3	10.33	6.000	41.92
500	9.1	11.00	5.500	50.00
REPLICATES				
100	2.0	10.25	10.25	0.000
250	4.8	8.833	6.333	28.30
450	8.3	9.375	5.875	37.33

Note: Each volume of detergent was injected into 5.0 mL of return activated sludge.

Respiration Data for Experiments with Versaclean that Resulted in Solubility Problems

3/18/93	$\%O_2$ UTILIZATION/MIN.		
SAM. VOL. (ul)	BLANK	VERSACLEAN	% CHANGE
CONTROL	35.00	32.00 (ND)	8.571
100	28.00	30.00	-7.143
200	23.25	23.00	10.75
300	23.50	21.00	10.64
400	23.00	17.75	22.83
500	23.17	18.50	20.15
600	23.50	15.62	33.53
700	22.50	15.62	30.58
800	23.83	16.50	30.76
900	22.83	16.75	26.63
1000	23.00	15.70	31.74
REPLICATES			
200	23.33	23.33	0.000
600	23.00	17.62	23.39
900	22.67	14.50	36.04

Note: Each volume of detergent was injected into 5.0 mL of return activated sludge.

Respiration Data for EZE 240

3/9/93		%O_2 UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	EZE 240	% CHANGE
CONTROL	0.00	23.00	31.00	-34.78
100	0.99	24.00	27.00	-12.50
200	2.0	27.00	17.75	34.26
300	2.9	24.25	11.37	53.11
400	3.8	23.50	8.250	64.89
500	4.8	22.50	5.667	74.81
600	5.7	23.00	4.000	82.61
700	6.5	21.67	2.875	86.73
800	7.4	21.75	2.333	89.27
900	8.3	20.00	2.250	88.75
1000	9.1	20.50	1.750	91.46
REPLICATES				
200	2.0	19.75	15.33	22.38
600	5.7	20.50	3.875	81.10
900	8.3	20.25	2.000	90.12

Note: Each volume of detergent was injected into 10.0 mL of return activated sludge.

Respiration Data for CITRANOX

3/9/93		$\%O_2$ UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	CITRANOX	% CHANGE
CONTROL	0.00	19.00	17.50	78.90
100	0.99	19.00	0.8571	95.49
200	2.0	18.67	0.6000	96.79
300	2.9	18.50	0.3333	98.20
400	3.8	18.67	0.2500	98.66
REPLICATES				
200	2.0	13.12	0.6000	95.43
300	2.9	11.33	0.5000	95.59
400	3.8	9.417	0.5833	93.81

Note: Each volume of detergent was injected into 10.0 mL of return activated sludge.

Respiration Data for MSI 1025

3/11/93		%O_2 UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	MSI 1025	% CHANGE
CONTROL	0.00	22.50	23.00	-2.220
100	.099	23.50	26.75	-13.83
200	2.0	17.66	20.50	-16.08
300	2.9	15.50	17.50	-12.90
400	3.8	18.83	20.00	-6.210
500	4.8	20.00	18.17	9.150
600	5.7	17.75	17.50	1.410
700	6.5	17.17	14.67	14.56
800	7.4	16.00	13.25	17.19
900	8.3	17.00	12.33	27.47
1000	9.1	15.33	10.25	33.14
REPLICATES				
200	2.0	14.50	17.75	-22.41
600	5.7	19.00	16.25	14.47
900	8.3	18.00	11.33	37.05

Note: Each volume of detergent was injected into 10.0 mL of return activated sludge.

Respiration Data for Ultraclean 8700

3/23/93		$\%O_2$ UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	Ultraclean 8700	% CHANGE
CONTROL	0.00	30.50	32.50	-6.560
100	0.99	32.50	14.50	55.38
200	2.0	32.00	18.00	43.75

Note: Each volume of detergent was injected into 10.0 mL of return activated sludge.

Respiration Data for Ultraclean 8700 from Experiments with Solubility Problems

4/14/93	$\%O_2$ UTILIZATION/MIN.		
SAM. VOL. (ul)	BLANK	ULTRACLEAN 8700	% CHANGE
CONTROL	7.667	7.722 (ND)	-0.7200
25	7.250	2.000	72.41
50	6.692	1.750	73.85
75	6.750	2.650	60.74
100	6.500	2.400	63.08
125	6.636	2.700	59.31
150	6.818	2.591	62.00
175	6.615	2.591	60.83
200	6.300	2.583	59.00
REPLICATES			
50	6.083	1.850	69.59
125	6.107	2.176	64.37
175	6.000	2.000	66.67

Note: Each volume of detergent was injected into 10.0 ml of return activated sludge.

Respiration Data for EZE 244

3/23/93		$\%O_2$ UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	EZE 244	% CHANGE
CONTROL	0.00	29.50	36.00	-22.03
100	0.99	28.00	23.33	17.86
200	2.0	26.50	11.67	55.96
300	2.9	28.83	8.357	71.01
400	3.8	26.50	5.555	79.04
500	4.8	27.50	4.300	84.36
600	5.7	26.75	3.571	86.65
700	6.5	27.00	3.429	87.30
800	7.4	21.83	4.091	81.26
900	8.3	24.50	2.357	90.38
1000	9.1	25.83	3.167	87.74
REPLICATES				
200	2.0	22.00	7.500	65.91
600	5.7	20.00	3.500	82.50
900	8.3	25.67	3.333	87.02

Note: Each volume of detergent was injected into 10.0 mL of return activated sludge.

Respiration Data for MSI 1084

3/24/93		%O_2 UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	MSI 1084	% CHANGE
CONTROL	0.00	39.00	34.50 (ND)	11.54
100	0.99	36.50	24.75	32.19
200	2.0	33.00	12.00	63.64
300	2.9	29.00	7.643	73.64
400	3.8	27.50	5.643	79.48
500	4.8	26.50	5.250	80.19
600	5.7	25.75	4.000	84.47
700	6.5	23.83	3.714	86.68
800	7.4	21.75	2.900	86.67
900	8.3	25.00	3.250	87.00
1000	9.1	25.50	3.143	87.67
REPLICATES				
200	2.0	23.00	11.10	51.74
600	5.7	22.25	4.167	81.27
900	8.3	23.25	3.143	86.48

Note: Each volume of detergent was injected into 10.0 mL of return activated sludge.

Respiration Data for SIMPLE GREEN

3/24/93		$\%O_2$ UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	SIMPLE GREEN	% CHANGE
CONTROL	0.00	25.50	24.25	4.902
100	0.99	24.00	33.50	-39.58
200	2.0	22.00	29.50	-34.09
300	2.9	23.33	26.00	-11.44
400	3.8	21.00	25.50	-21.43
500	4.8	24.67	26.00	-5.391
600	5.7	23.33	23.33	0.000
700	6.5	23.25	19.50	16.13
800	7.4	23.50	18.00	23.40
900	8.3	24.50	16.75	31.63
1000	9.1	23.33	14.25	38.92
REPLICATES				
200	2.0	24.67	32.00	-29.71
600	5.7	24.50	23.25	3.125
900	8.3	24.00	16.50	31.25

Note: Each volume of detergent was injected into 10.0 mL of return activated sludge.

Respiration Data for BRULIN 815 QR

3/25/93		$\%O_2$ UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	BRULIN 815 QR	% CHANGE
CONTROL	0.00	36.50	34.00	6.850
100	0.99	36.00	10.50	70.83
200	2.0	36.00	4.312	88.02
300	2.9	19.00	3.700	80.53

Note: Each volume of detergent was injected into 10.0 mL of return activated sludge.

Respiration Data for Simple Green from Experiment with Solubility Problems

4/15/93	$\%O_2$ UTILIZATION/MIN.		
SAM. VOL. (ul)	BLANK	Simple Green	% CHANGE
CONTROL	12.60	11.00 (ND)	12.70
25	11.20	10.00	10.71
50	8.444	4.800	43.15
75	8.937	3.187	64.34
100	6.833	2.389	65.04
125	7.222	1.500	79.23
150	7.333	1.500	79.54
175	7.000	1.250	82.14
200	6.727	0.9167	86.37
REPLICATES			
50	6.500	4.071	37.37
125	7.062	1.583	77.59
175	6.250	1.300	79.20

Note: Each volume of detergent was injected into 10.0 mL of return activated sludge.

Respiration Data for AQUA #1

4/1/93		%O_2 UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	AQUA #1	% CHANGE
CONTROL	0.00	13.00	14.67	-12.85
100	0.99	12.00	14.50	-20.83
200	2.0	8.500	9.125	-7.350
300	2.9	9.583	4.450	53.56
400	3.8	9.000	2.667	70.37
500	4.8	8.500	1.600	81.18
600	5.7	8.714	1.786	79.50
700	6.5	6.800	1.636	75.94
800	7.4	11.42	0.300	97.37
REPLICATES				
200	2.0	12.80	3.500	72.66
500	4.8	12.60	0.000	100.0
700	6.5	13.00	1.000	92.31

Note: Each volume of detergent was injected into 10.0 mL of return activated sludge.

Respiration Data for HURRI-SAFE

4/6/93		$\%O_2$ UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	HURRI-SAFE	% CHANGE
CONTROL	0.00	9.000	10.00	11.11
100	0.99	10.43	14.30	37.10
200	2.0	9.562	7.222	24.47
300	2.9	9.500	3.727	60.77
400	3.8	11.21	2.600	76.81
500	4.8	9.389	1.600	89.35
600	5.7	9.750	0.6067	93.78
700	6.5	12.75	0.7500	94.12
REPLICATES				
200	2.0	10.00	6.083	39.17
500	4.8	11.07	2.200	80.13
600	5.7	9.250	0.7500	91.89

Note: Each volume of detergent was injected into 10.0 mL of return activated sludge.

Respiration Data for MA-102

4/7/93		$\%O_2$ UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	MA-102	% CHANGE
CONTROL	0.00	15.62	16.17	-3.520
100	0.99	15.40	16.40	-6.490
200	2.0	15.17	11.92	21.42
300	2.9	12.80	10.08	21.25
400	3.8	11.93	7.625	36.09
500	4.8	14.50	7.625	47.41
600	5.7	14.20	6.333	55.40
700	6.5	13.50	5.375	60.19
800	7.4	12.58	4.773	62.06
900	8.3	12.08	4.417	63.44
1000	9.1	12.86	4.000	68.90
REPLICATES				
200	2.0	13.00	10.62	18.31
600	5.7	13.75	6.200	54.91
900	8.3	13.33	4.437	66.71

Note: Each volume of detergent was injected into 10.0 mL of return activated sludge.

Respiration Data for CAVI-CLEAN

4/7/93		%O_2 UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	CAVI-CLEAN	% CHANGE
CONTROL	0.00	13.10	12.33	5.880
100	0.99	14.00	12.80	8.570
200	2.0	13.00	9.417	27.56
300	2.9	13.00	10.14	22.00
400	3.8	12.50	10.29	17.68
500	4.8	12.71	10.86	14.56
600	5.7	12.36	10.71	13.35
700	6.5	12.33	10.75	12.81
800	7.4	12.42	11.30	9.020
900	8.3	12.10	11.80	2.480
1000	9.1	12.25	11.08	9.550
REPLICATES				
200	2.0	11.60	10.36	10.69
600	5.7	12.00	9.643	19.64
900	8.3	12.25	11.36	7.270

Note: Each volume of detergent was injected into 10.0 mL of return activated sludge.

Respiration Data for TRITON X-100

4/8/93		$\%O_2$ UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	TRITON X-100	% CHANGE
CONTROL	0.00	12.17	14.67	-20.54
100	0.99	11.90	15.17	-27.48
200	2.0	12.08	13.50	-11.75
300	2.9	11.57	11.67	-0.860
400	3.8	11.26	12.36	-9.770
500	4.8	11.67	12.00	-2.830
600	5.7	12.08	13.00	-7.620
700	6.5	11.67	12.10	-3.680
800	7.4	11.86	10.93	7.840
900	8.3	11.12	11.12	0.000
1000	9.1	10.44	12.21	-16.95
REPLICATES				
200	2.0	12.17	11.71	3.780
600	5.7	11.12	12.12	-8.990
900	8.3	11.50	11.67	-1.480

Note: Each volume of detergent was injected into 10.0 mL of return activated sludge.

Respiration Data for KYZEN X-2031

4/8/93		%O_2 UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	KYZEN X-2031	% CHANGE
CONTROL	0.00	23.00	22.33	2.910
100	0.99	22.00	16.00	50.00
200	2.0	20.50	9.667	52.84
300	2.9	15.40	5.357	65.21
400	3.8	14.08	3.187	77.37
500	4.8	13.50	2.500	81.48
600	5.7	12.08	1.875	84.48
700	6.5	12.92	1.556	87.96
800	7.4	12.64	1.357	89.26
900	8.3	12.50	1.286	89.71
1000	9.1	12.10	1.200	90.08
REPLICATES				
200	2.0	11.50	7.333	36.23
600	5.7	11.62	1.875	83.86
900	8.3	11.60	1.125	90.30

Note: Each volume of detergent was injected into 10.0 mL of return activated sludge.

Respiration Data for OAKITE X-91-5

4/9/93		$\%O_2$ UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	OAKITE X-91-5	% CHANGE
CONTROL	0.00	22.50	21.62	3.910
100	0.99	21.67	14.75	31.93
200	2.0	18.83	7.900	58.05
300	2.9	14.83	2.812	81.04
400	3.8	16.00	2.833	82.29
500	4.8	12.90	2.417	81.26
600	5.7	12.00	2.250	81.25
700	6.5	12.50	2.375	81.00
800	7.4	11.64	3.000	74.23
900	8.3	11.29	2.143	81.02
1000	9.1	11.17	2.500	77.62
REPLICATES				
200	2.0	11.30	4.833	57.23
600	5.7	11.10	2.417	78.23
900	8.3	11.07	2.429	78.06

Note: Each volume of detergent was injected into 10.0 mL of return activated sludge.

Respiration Data for PF DEGREASER

4/9/93		$\%O_2$ UTILIZATION/MIN.		
SAM. VOL. (ul)	% DET. (vol/vol)	BLANK	PF DEGREASER	% CHANGE
CONTROL	0.00	10.86	11.21	-3.220
100	0.99	11.58	10.28	11.23
200	2.0	10.93	8.187	25.10
300	2.9	11.00	6.036	45.13
400	3.8	11.07	7.136	35.54

Note: Each volume of detergent was injected into 10.0 mL of return activated sludge.

APPENDIX B
PHASE II. BIODEGRADATION POTENTIAL STUDY DATA

Appendix B

Phase II. Biodegradation Potential Study Data

The data contained in the following tables are the results from laboratory experiments conducted to examine the biodegradability of the detergents based on CO_2 evolution, COD reduction, and solids production. These data were used to calculate the values reported in the body of this report. The following sample calculations illustrate how the data were used to calculate the CO_2 evolved and the solids values reported for this Phase II. The COD values are the direct readouts from the spectrophotometer corrected for any dilution.

Example: Simple Green replicate B

CO_2 Production:

$$1\,mg\,CO_{2_{produced}} = 6\,mEquivalent\,KOH_{consumed}$$

$$KOH_{consumed}(mEquivalent) = KOH_{total}(mEquivalent) - HCl_{added})mEquivalent$$

$$CO_{2_{produced}}(mg) = 6 \times (10\,mL \times \frac{1\,L}{1000\,mL} \times 1000\,\frac{mEquivalents}{L} - HCl_{added}(mL) \times \frac{1\,L}{1000\,mL} \times 250\,\frac{mEquivalents}{L})$$

$$CO_{2_{produced}}(mg) = 6 \times (10 - (0.25 \times HCL_{added}(mL)))$$

$$CO_{2_{produced}} = 6 \times (10 - (0.25 \times 25(mL)))$$

$$CO_{2_{produced}} = 22.5(mg)$$

Solids data:

$$Total\ Solids\ (mg/L) = \frac{(Dish\ \&\ Sample\ Wt.(103^{\circ}C)(grams) - Dish\ Wt.(grams))\ X\ \frac{1000\,mg}{1gram}}{Sample\ Volume(mL)}\ X\ \frac{1000\,mL}{1L}$$

$$Total Solids(mg/L) = \frac{(1.3981g - 1.3545g) + 1000}{5\,mL} X 1000$$

$$Total Solids(mg/L) = 8{,}720(mg/L)$$

$$Volatile Solids(mg/L) = Total Solids(mg/L) - \frac{Dish\ \&\ Sample\ Wt.(105^{\circ}C)(grams) - Dish\ \&\ Sample\ Wt.(550^{\circ}C)(grams)\ X\ \frac{1000\,mg}{1gram}}{Sample\ Volume(mL)}\ X\ \frac{1000\,mL}{1L}$$

$$Volatile Solids(mg/L) = 8{,}720(mg/L) - \frac{(1.3981 - 1.3665) X 1000}{5mL} X 1000$$

$$Volatile Solids(mg/L) = 2{,}400(mg/L)$$

Newark A.F.B. Detergent Biodegradability Study
Detergent Biodegradability (Phase #2)

Date: 5/11/93

Sample	Replicate	Acid Used (ml)	CO2 (mg)	Avg. CO2 (mg)
Simple Green	A	31.0 *	−33.0	
	B	25.0	22.5	28.9
	C	16.5	35.3	
Simple Green (Sterile)	A	18.7	32.0	
	B	16.9	34.7	34.0
	C	16.5	35.3	
Intex 8125	A	16.8	34.8	
	B	15.2	37.2	36.3
	C	15.4	36.9	
Intex 8125 (Sterile)	A	16.2	35.7	
	B	18.5	32.3	33.9
	C	17.5	33.8	
Cavi−Clean	A	10.4	44.4	
	B	10.4	44.4	41.3
	C	16.6	35.1	
Cavi−Clean (Sterile)	A	16.2	35.7	
	B	18.0	33.0	34.6
	C	16.6	35.1	
Versa Clean	A	15.9	36.2	
	B	14.7	38.0	37.0
	C	15.5	36.8	
Versa Clean (Sterile)	A	18.1	32.9	
	B	16.7	35.0	34.1
	C	17.1	34.4	
Controls (No Detergent)	A	15.3	37.1	
	B	19.1	31.4	
	C	17.9	33.2	34.5
	D	15.9	36.2	
	E	17.3	34.1	
	F	16.6	35.1	

* This sample was titrated with 0.5 N HCl

Newark A.F.B. Detergent Biodegradability Study
Detergent Biodegradability (Phase #2)

Date: 5/13/93

Sample	Replicate	Acid Used (ml)	CO2 (mg)	Avg. CO2 (mg)
Hurri Safe	A	16.5	35.3	
	B	16.5	35.3	34.0
	C	19.1	31.4	
Hurri Safe	A	18.1	32.9	
(Sterile)	B	17.8	33.3	33.2
	C	17.8	33.3	
Aqua #1	A	16.0	36.0	
	B	16.8	34.8	35.1
	C	17.0	34.5	
Aqua #1	A	17.2	34.2	
(Sterile)	B	17.9	33.2	33.8
	C	17.3	34.1	
EZ 240	A	16.8	34.8	
	B	16.2	35.7	35.2
	C	16.7	35.0	
EZ 240	A	16.7	35.0	
(Sterile)	B	16.6	35.1	35.3
	C	16.1	35.9	
Kyzen X−20−11	A	15.6	36.6	
	B	16.4	35.4	35.7
	C	16.7	35.0	
Kyzen X−20−11	A	16.6	35.1	
(Sterile)	B	16.3	35.6	35.1
	C	17.0	34.5	
Controls	A	17.4	33.9	
(No Detergent)	B	16.3	35.6	
	C	16.9	34.7	35.4
	D	15.7	36.5	
	E	15.8	36.3	
	F	16.2	35.7	

Newark A.F.B. Detergent Biodegradability Study
Detergent Biodegradability (Phase #2)

Date: 6/3/93

Sample	Replicate	Acid Used (ml)	CO2 (mg	Avg. CO2 (mg)
Oakite	A	17.2	34.2	
	B	16.4	35.4	35.3
	C	15.9	36.2	
Oakite (Sterile)	A	16.0	36.0	
	B	15.8	36.3	36.5
	C	15.2	37.2	
Citranox	A	15.6	36.6	
	B	16.2	35.7	36.2
	C	15.9	36.2	
Citranox (Sterile)	A	15.7	36.5	
	B	15.4	36.9	36.8
	C	15.4	36.9	
MSI 1025	A	16.3	35.6	
	B	14.2	38.7	37.1
	C	15.3	37.1	
MSI 1025 (Sterile)	A	15.6	36.6	
	B	14.7	38.0	36.6
	C	16.5	35.3	
EZE 244	A	15.8	36.3	
	B	15.9	36.2	36.1
	C	16.2	35.7	
EZE 244 (Sterile)	A	16.2	35.7	
	B	15.0	37.5	36.5
	C	15.9	36.2	
Controls (No Detergent & Sterile)	A	15.6	36.6	
	B	16.6	35.1	35.8
	C	16.3	35.6	
Controls (No Detergent)	A	15.7	36.5	
	B	16.7	35.0	36.5
	C	16.3	35.6	

Newark A.F.B. Detergent Biodegradability Study
Detergent Biodegradability (Phase #2)

Date: 5/20/93

Sample	Replicate	Acid Used (ml)	CO2 (mg)	Avg. CO2 (mg)
Formula 815	A	14.3	38.6	
	B	16.9	34.7	36.3
	C	16.3	35.6	
Formula 815 (Sterile)	A	15.1	37.4	
	B	13.1	40.4	38.9
	C	14.0	39.0	
815 QR	A	16.6	35.1	
	B	16.7	35.0	33.3
	C	20.2	29.7	
815 QR (Sterile)	A	14.5	38.3	
	B	14.5	38.3	37.8
	C	15.5	36.8	
MA–102	A	16.8	34.8	
	B	16.6	35.1	35.1
	C	16.4	35.4	
MA–102 (Sterile)	A	14.7	38.0	
	B	14.8	37.8	37.6
	C	15.4	36.9	
Triton X–100	A	17.2	34.2	
	B	16.4	35.4	34.8
	C	16.8	34.8	
Triton X–100 (Sterile)	A	15.3	37.1	
	B	15.8	36.3	36.7
	C	15.5	36.8	
Controls (No Detergent & Sterile)	A	16.0	36.0	
	B	16.3	35.6	35.8
	C	16.1	35.9	
Controls (No Detergent)	A	14.4	38.4	
	B	16.6	35.1	36.1
	C	16.8	34.8	

Newark A.F.B. Detergent Biodegradability Study
Detergent Biodegradability (Phase #2)

Date: 5/27/93

Sample	Replicate	Acid Used (ml)	CO2 (mg)	Avg. CO2 (mg)
Ultraclean 8700	A	16.8	34.8	
	B	16.0	36.0	35.6
	C	16.1	35.9	
Ultraclean 8700 (Sterile)	A	13.1	40.4	
	B	12.7	41.0	40.6
	C	13.0	40.5	
Intex 8284	A	17.0	34.5	
	B	16.9	34.7	34.8
	C	16.5	35.3	
Intex 8284 (Sterile)	A	13.2	40.2	
	B	13.2	40.2	40.0
	C	13.7	39.5	
Oakite X-91-5	A	16.4	35.4	
	B	16.7	35.0	35.2
	C	16.6	35.1	
Oakite X-91-5 (Sterile)	A	13.9	39.2	
	B	14.1	38.9	38.7
	C	14.7	38.0	
PF Degreaser	A	16.9	34.7	
	B	16.6	35.1	35.0
	C	16.6	35.1	
PF Degreaser (Sterile)	A	14.4	38.4	
	B	15.0	37.5	37.8
	C	15.1	37.4	
Controls (No Detergent & Sterile)	A	15.3	37.1	
	B	15.8	36.3	36.9
	C	15.1	37.4	
Controls (No Detergent)	A	16.6	35.1	
	B	16.3	35.6	35.1
	C	17.0	34.5	

COD DATA FOR BIOMETER FLASK DETERGENT BIODEGRADABILITY STUDY (PHASE #2)

DETERGENT: SIMPLE GREEN

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	81.0	727.0	177.0	1241.0	NA	51.0
B	53.0	465.0	185.0	1363.0	NA	42.0
C	50.0	444.0	167.0	1345.0	NA	47.0
D						35.0
E						41.0
F						45.0
AVG.	61.3	545.3	176.3	1316.3	NA	43.5
C.V.	22.8	23.6	4.2	4.1	NA	11.6
COD (mg/L)	122.7	1090.7	352.7	2632.7	1303.2	87.0

Bio. Deg. Rate (%) 80.0

DETERGENT: INTEX 8125

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	81.0	613.0	596.0	1650.0	NA	51.0
B	53.0	713.0	478.0	1650.0	NA	42.0
C	50.0	851.0	462.0	1650.0	NA	47.0
D						35.0
E						41.0
F						45.0
AVG.	61.3	725.7	512.0	1650.0	NA	43.5
C.V.	22.8	47.6	11.7	0.0	NA	11.6
COD (mg/L)	122.7	1451.3	1024.0	3300.0	1303.2	87.0

Bio. Deg. Rate (%) 53.1

DETERGENT: CAVI–CLEAN

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	81.0	880.0	553.0	1151.0	NA	51.0
B	53.0	747.0	448.0	1167.0	NA	42.0
C	50.0	614.0	472.0	1325.0	NA	47.0
D						35.0
E						41.0
F						45.0
AVG.	61.3	747.0	491.0	1214.3	NA	43.5
C.V.	22.8	14.5	9.1	6.5	NA	11.6
COD (mg/L)	122.7	1494.0	982.0	2428.7	1303.2	87.0

Bio. Deg. Rate (%) 20.5

COD DATA FOR BIOMETER FLASK DETERGENT BIODEGRADABILITY STUDY (PHASE #2)

DETERGENT: VERSA CLEAN

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	81.0	463.0	257.0	1449.0	NA	51.0
B	53.0	613.0	256.0	1480.0	NA	42.0
C	50.0	518.0	234.0	1650.0	NA	47.0
D						35.0
E						41.0
F						45.0
AVG.	61.3	531.3	249.0	1526.3	NA	43.5
C.V.	22.8	11.7	4.3	5.8	NA	11.6
COD (mg/L)	122.7	1062.7	498.0	3052.7	1303.2	87.0
Bio. Deg. Rate (%)	76.5					

DETERGENT: HURRI-SAFE

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	28.0	174.0	854.0	348.0	NA	28.0
B	17.0	185.0	1319.0	403.0	NA	62.0
C	28.0	186.0	820.0	412.0	NA	59.0
D						593.0
E						60.0
F						61.0
AVG.	24.3	181.7	837.0	387.7	NA	45.0
C.V.	21.3	3.0	2.0	7.3	NA	29.0
COD (mg/L)	97.3	3633.3	3348.0	7753.3	1032.3	90.0
Bio. Deg. Rate (%)	51.5					

DETERGENT: AQUA #1

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	28.0	53.0	254.0	201.0	NA	28.0
B	17.0	68.0	290.0	198.0	NA	62.0
C	28.0	68.0	246.0	212.0	NA	59.0
D						593.0
E						60.0
F						61.0
AVG.	24.3	63.0	263.3	203.7	NA	45.0
C.V.	21.3	11.2	7.3	3.0	NA	29.0
COD (mg/L)	97.3	1260.0	1053.3	4073.3	1032.3	90.0
Bio. Deg. Rate (%)	68.3					

COD DATA FOR BIOMETER FLASK DETERGENT BIODEGRADABILITY STUDY (PHASE #2)

DETERGENT: EZ 240

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	28.0	108.0	363.0	240.0	NA	28.0
B	17.0	108.0	386.0	241.0	NA	62.0
C	28.0	110.0	354.0	216.0	NA	59.0
D						593.0
E						60.0
F						61.0
AVG.	24.3	108.7	367.7	232.3	NA	45.0
C.V.	21.3	0.9	3.7	5.0	NA	29.0
COD (mg/L)	97.3	2173.3	1470.7	4646.7	1032.3	90.0
Bio. Deg. Rate (%)	61.8					

DETERGENT: KYZEN X-20-11

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	28.0	676.0	345.0	699.0	NA	28.0
B	17.0	444.0	433.0	776.0	NA	62.0
C	28.0	609.0	333.0	813.0	NA	59.0
D						593.0
E						60.0
F						61.0
AVG.	24.3	576.3	370.3	762.7	NA	45.0
C.V.	21.3	16.9	12.0	6.2	NA	29.0
COD (mg/L)	97.3	11526.7	1481.3	15253.3	1032.3	90.0
Bio. Deg. Rate (%)	90.2					

DETERGENT: FORMULA 815

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	0.0	3.0	916.0	155.0	398.0	26.0
B	0.0	2.0	149.0	135.0	342.0	24.0
C	0.0	12.0	141.0	148.0	349.0	29.0
AVG.	0.0	5.7	402.0	146.0	363.0	26.3
C.V.	ERR	79.4	90.4	5.7	6.9	7.8
COD (mg/L)	0.0	113.3	1608.0	2920.0	1452.0	52.7
Bio. Deg. Rate (%)	-5.9					

COD DATA FOR BIOMETER FLASK DETERGENT BIODEGRADABILITY STUDY (PHASE #2)

DETERGENT: 815 QR

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	0.0	21.0	128.0	159.0	398.0	26.0
B	0.0	15.0	159.0	157.0	342.0	24.0
C	0.0	21.0		165.0	349.0	29.0
AVG.	0.0	19.0	95.7	160.3	363.0	26.3
C.V.	ERR	14.9	16.2	2.1	6.9	7.8
COD (mg/L)	0.0	380.0	382.7	3206.7	1452.0	52.7

Bio. Deg. Rate (%) 81.2

DETERGENT: MA-102

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	0.0	50.0	385.0	195.0	398.0	26.0
B	0.0	66.0	431.0	236.0	342.0	24.0
C	0.0	63.0	638.0	170.0	349.0	29.0
AVG.	0.0	59.7	484.7	200.3	363.0	26.3
C.V.	ERR	11.6	22.7	13.6	6.9	7.8
COD (mg/L)	0.0	1193.3	1938.7	4006.7	1452.0	52.7

Bio. Deg. Rate (%) 26.2

DETERGENT: TRITON X-100

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	0.0	438.0	1439.0	1266.0	398.0	26.0
B	0.0	327.0	1233.0	1092.0	342.0	24.0
C	0.0	956.0	1066.0	874.0	349.0	29.0
AVG.	0.0	573.7	1246.0	1077.3	363.0	26.3
C.V.	ERR	47.8	12.2	14.9	6.9	7.8
COD (mg/L)	0.0	11473.3	4984.0	21546.7	1452.0	52.7

Bio. Deg. Rate (%) 75.5

COD DATA FOR BIOMETER FLASK DETERGENT BIODEGRADABILITY STUDY (PHASE #2)

DETERGENT: ULTRACLEAN 8700

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	35.0	98.0	891.0	150.0	376.0	49.0
B	49.0	98.0	760.0	161.0	352.0	35.0
C	14.0	113.0	671.0	168.0	342.0	58.0
AVG.	32.7	103.0	774.0	159.7	356.7	47.3
C.V.	44.0	6.9	11.7	4.6	4.0	20.0
COD (mg/L)	130.7	2060.0	3096.0	3193.3	1426.7	94.7
Bio. Deg. Rate (%)	−69.9					

DETERGENT: INTEX 8284

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	35.0	559.0	146.0	108.0	376.0	49.0
B	49.0	497.0	101.0	120.0	352.0	35.0
C	14.0	474.0	179.0	117.0	342.0	58.0
AVG.	32.7	510.0	142.0	115.0	356.7	47.3
C.V.	44.0	7.0	22.5	4.4	4.0	20.0
COD (mg/L)	130.7	10200.0	568.0	2300.0	1426.7	94.7
Bio. Deg. Rate (%)	45.8					

DETERGENT: OAKITE X−91−5

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	35.0	84.0	67.0	178.0	376.0	49.0
B	49.0	100.0	69.0	179.0	352.0	35.0
C	14.0	80.0	176.0	187.0	342.0	58.0
AVG.	32.7	88.0	104.0	181.3	356.7	47.3
C.V.	44.0	9.8	49.0	2.2	4.0	20.0
COD (mg/L)	130.7	1760.0	416.0	3626.7	1426.7	94.7
Bio. Deg. Rate (%)	85.4					

COD DATA FOR BIOMETER FLASK DETERGENT BIODEGRADABILITY STUDY (PHASE #2)

DETERGENT: PF DEGREASER

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	35.0	10.0	49.0	81.0	376.0	49.0
B	49.0	84.0	72.0	81.0	352.0	35.0
C	14.0	15.0	80.0	82.0	342.0	58.0
AVG.	32.7	36.3	67.0	81.3	356.7	47.3
C.V.	44.0	92.9	19.6	0.6	4.0	20.0
COD (mg/L)	130.7	726.7	268.0	1626.7	1426.7	94.7
Bio. Deg. Rate (%)	13.3					

DETERGENT: OAKITE

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	47.0	69.0	309.0	214.0	428.0	93.0
B	35.0	81.0	305.0	219.0	407.0	97.0
C	37.0	73.0	278.0	211.0	397.0	94.0
AVG.	39.7	74.3	297.3	214.7	410.7	94.7
C.V.	13.2	6.7	4.6	1.5	3.1	1.8
COD (mg/L)	158.7	1486.7	1189.3	4293.3	1642.7	189.3
Bio. Deg. Rate (%)	62.3					

DETERGENT: CITRANOX

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	47.0	66.0	339.0	237.0	428.0	93.0
B	35.0	74.0	283.0	166.0	407.0	97.0
C	37.0	71.0	226.0	180.0	397.0	94.0
AVG.	39.7	70.3	282.7	194.3	410.7	94.7
C.V.	13.2	4.7	16.3	15.8	3.1	1.8
COD (mg/L)	158.7	1406.7	1130.7	3886.7	1642.7	189.3
Bio. Deg. Rate (%)	58.1					

COD DATA FOR BIOMETER FLASK DETERGENT BIODEGRADABILITY STUDY (PHASE #2)

DETERGENT: MSI 1025

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	47.0	79.0	218.0	209.0	428.0	93.0
B	35.0	101.0	307.0	211.0	407.0	97.0
C	37.0	105.0	232.0	216.0	397.0	94.0
AVG.	39.7	95.0	252.3	212.0	410.7	94.7
C.V.	13.2	12.0	15.5	1.4	3.1	1.8
COD (mg/L)	158.7	1900.0	1009.3	4240.0	1642.7	189.3
Bio. Deg. Rate (%)	68.4					

DETERGENT: EZE 244

REPLICATE	INITIAL BLANK	INITIAL	FINAL	STERILE CONTROL	STERILE BLANK	BLANK CONTROL
A	47.0	153.0	254.0	265.0	428.0	93.0
B	35.0	167.0	197.0	292.0	407.0	97.0
C	37.0	176.0	215.0	270.0	397.0	94.0
AVG.	39.7	165.3	222.0	275.7	410.7	94.7
C.V.	13.2	5.7	10.7	4.3	3.1	1.8
COD (mg/L)	158.7	3306.7	888.0	5513.3	1642.7	189.3
Bio. Deg. Rate (%)	81.9					

SOLIDS REDUCTION

Date: 5/11/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 5.0 mL			
A	1.3650	1.3989	1.3733	6780.0	1660.0
B	1.3698	1.4025	1.3776	6540.0	1560.0
C	1.3679	1.4046	1.3768	7340.0	1780.0
			Average	6886.7	1666.7
			C.V.	4.9	5.4
Detergent:	Intex 8125 (100%)	Sample Vol. 5.0 mL			
A	1.2807	1.8019	1.4786	104240.0	39580.0
B	1.2872	1.7850	1.4853	99560.0	39620.0
C	1.2854	1.8217	1.4803	107260.0	38980.0
			Average	103686.7	39393.3
			C.V.	3.1	0.7
Flask:	Blank Control	Sample Vol. 5.0 mL			
A	1.3555	1.3943	1.3667	7760.0	2240.0
B	1.3559	1.3944	1.3670	7700.0	2220.0
C	1.3584	1.3976	1.3696	7840.0	2240.0
D	1.3595	1.3983	1.3707	7760.0	2240.0
E	1.3677	1.4059	1.3786	7640.0	2180.0
F	1.3699	1.4033	1.3793	6680.0	1880.0
			Average	7563.3	2166.7
			C.V.	5.3	6.0
Detergent:	Intex 8125 Sterile Control	Sample Vol. 5.0 mL			
A	1.3660	1.4015	1.3756	7100.0	1920.0
B	1.3646	1.3997	1.3738	7020.0	1840.0
C	1.3602	1.3949	1.3703	6940.0	2020.0
			Average	7020.0	1926.7
			C.V.	0.9	3.8
Detergent:	Intex 8125	Sample Vol. 5.0 mL			
A	1.3585	1.3935	1.3675	7000.0	1800.0
B	1.3593	1.3960	1.3685	7340.0	1840.0
C	1.3633	1.3978	1.3720	6900.0	1740.0
			Average	7080.0	1793.3
			C.V.	2.7	2.3

Summary of Calculated Solids Results
for
Intex 8125

Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Initial Blank	6886.7	1666.7
Detergent (100%)	103686.7	39393.3
Initial Detergent	7405.1	1863.7
Blank Control	7563.3	2166.7
Sterile Control	7020.0	1926.7
Detergent (After Incubation)	7080.0	1793.3

	Changes in Solids Concentration	
Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Blank Control – Initial Blank	676.6	500.0
Sterile Control – Initial Detergent	−385.1	63.0
Detergent (After Incubation) – Initial Detergent	−325.1	−70.4

SOLIDS REDUCTION

Date: 6/3/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 3.0 mL			
A	1.2820	1.3024	1.2881	6800.0	2033.3
B	1.2746	1.2947	1.2808	6700.0	2066.7
C	1.2815	1.3012	1.2873	6566.7	1933.3
			Average	6688.9	2011.1
			C.V.	1.4	2.8
Detergent:	Oakite (100%)	Sample Vol. 5.0 mL			
A	1.2873	1.8327	1.4436	109080.0	31260.0
B	1.2893	1.8407	1.4715	110280.0	36440.0
C	1.2841	1.8450	1.4624	112180.0	35660.0
			Average	110513.3	34453.3
			C.V.	1.2	6.6
Flask:	Blank Control	Sample Vol. 3.0 mL			
A	1.2934	1.3127	1.2997	6433.3	2100.0
B	1.2932	1.3128	1.2996	6533.3	2133.3
C	1.2955	1.3148	1.3018	6433.3	2100.0
			Average	6466.7	2111.1
			C.V.	0.7	0.7
Flask:	Sterile Blank	Sample Vol. 3.0 mL			
A	1.2891	1.3155	1.2973	8800.0	2733.3
B	1.2877	1.3119	1.2953	8066.7	2533.3
C	1.2889	1.3140	1.2965	8366.7	2533.3
			Average	8411.1	2600.0
			C.V.	3.6	3.6
Detergent:	Oakite Sterile Control	Sample Vol. 3.0 mL			
A	1.2833	1.3118	1.2916	9500.0	2766.7
B	1.2878	1.3154	1.2958	9200.0	2666.7
C	1.2791	1.3080	1.2879	9633.3	2933.3
			Average	9444.4	2788.9
			C.V.	1.9	3.9
Detergent:	Oakite	Sample Vol. 3.0 mL			
A	1.2781	1.3004	1.2854	7433.3	2433.3
B	1.2744	1.2962	1.2815	7266.7	2366.7
C	1.2777	1.2995	1.2843	7266.7	2200.0
			Average	7322.2	2333.3
			C.V.	1.1	4.2

Summary of Calculated Solids Results
for
Oakite

Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Initial Blank	6688.9	2011.1
Detergent (100%)	1105113.3	34453.3
Initial Detergent	7241.5	2183.4
Blank Control	6466.7	2111.1
Sterile Control	9444.4	2788.9
Detergent (After Incubation)	7322.2	2333.3

	Changes in Solids Concentration	
Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Blank Control – Initial Blank	−222.2	100.0
Sterile Control – Initial Detergent	2202.9	605.5
Detergent (After Incubation) – Initial Detergent	80.7	149.9

SOLIDS REDUCTION

Date: 5/20/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 5.0 mL			
A	1.2900	1.3236	1.3005	6720.0	2100.0
B	1.2875	1.3187	1.2974	6240.0	1980.0
C	1.2913	1.3242	1.3008	6580.0	1900.0
			Average	6513.3	1993.3
			C.V.	3.1	4.1
Detergent:	Formula 815 GD (100%)	Sample Vol. 5.0 mL			
A	1.2819	1.9912	1.6674	141860.0	77100.0
B	1.2828	1.9464	1.6790	132720.0	79240.0
C	1.2849	1.8453	1.6854	112080.0	80100.0
			Average	128886.7	78813.3
			C.V.	9.7	1.6
Flask:	Blank Control	Sample Vol. 5.0 mL			
A	1.2901	1.3218	1.2998	6340.0	1940.0
B	1.2878	1.3199	1.2978	6420.0	2000.0
C	1.2932	1.3244	1.3029	6240.0	1940.0
			Average	6333.3	1960.0
			C.V.	1.2	1.4
Flask:	Sterile Blank	Sample Vol. 5.0 mL			
A	1.2873	1.3278	1.3000	8100.0	2540.0
B	1.2903	1.3287	1.3015	7680.0	2240.0
C	1.2898	1.3279	1.3015	7620.0	2340.0
			Average	7800.0	2373.3
			C.V.	2.7	5.3
Detergent:	Formula 815 GD Sterile Control	Sample Vol. 4.0 mL			
A	1.2846	1.3217	1.2985	9275.0	2975.0
B	1.2910	1.3263	1.3016	8825.0	2650.0
C	1.2931	1.3311	1.3039	9500.0	2700.0
			Average	9200.0	2775.0
			C.V.	3.1	5.1
Detergent:	Formula 815 GD	Sample Vol. 5.0 mL			
A	1.2917	1.4312	1.3980	27900.0	21260.0
B	1.2924	1.3303	1.3044	7580.0	2400.0
C	1.2888	1.3246	1.3003	7160.0	2300.0
			Average	7370.0	2350.0
			C.V.	2.8	2.1

Summary of Calculated Solids Results
for
Formula 815 GD

Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Initial Blank	6513.3	1993.3
Detergent (100%)	128886.7	78813.3
Initial Detergent	7157.7	2387.4
Blank Control	6333.3	1960.0
Sterile Control	9200.0	2775.0
Detergent (After Incubation)	7370.0	2350.0

	Changes in Solids Concentration	
Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Blank Control – Initial Blank	−180.0	−33.3
Sterile Control – Initial Detergent	2042.3	387.6
Detergent (After Incubation) – Initial Detergent	212.3	−37.4

SOLIDS REDUCTION

Date: 5/11/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 5.0 mL			
A	1.3650	1.3989	1.3733	6780.0	1660.0
B	1.3698	1.4025	1.3776	6540.0	1560.0
C	1.3679	1.4046	1.3768	7340.0	1780.0
			Average	6886.7	1666.7
			C.V.	4.9	5.4
Detergent:	Versa Clean (100%)	Sample Vol. 5.0 mL			
A	1.2825	1.4235	1.3284	28200.0	9180.0
B	1.2781	1.5700	1.3327	58380.0	10920.0
C	1.2786	1.3816	1.3282	20600.0	9920.0
			Average	24400.0	9550.0
			C.V.	15.6	3.9
Flask:	Blank Control	Sample Vol. 5.0 mL			
A	1.3555	1.3943	1.3667	7760.0	2240.0
B	1.3559	1.3944	1.3670	7700.0	2220.0
C	1.3584	1.3976	1.3696	7840.0	2240.0
D	1.3595	1.3983	1.3707	7760.0	2240.0
E	1.3677	1.4059	1.3786	7640.0	2180.0
F	1.3699	1.4033	1.3793	6680.0	1880.0
			Average	7563.3	2166.7
			C.V.	5.3	6.0
Detergent:	Versa Clean Sterile Control	Sample Vol. 5.0 mL			
A	1.3537	1.4061	1.3671	10480.0	2680.0
B	1.3557	1.4042	1.3680	9700.0	2460.0
C	1.3568	1.4144	1.3786	11520.0	4360.0
			Average	10090.0	2570.0
			C.V.	3.9	4.3
Detergent:	Versa Clean	Sample Vol. 5.0 mL			
A	1.3630	1.3987	1.3721	7140.0	1820.0
B	1.3660	1.4016	1.3748	7120.0	1760.0
C	1.3686	1.4025	1.3771	6780.0	1700.0
			Average	7013.3	1760.0
			C.V.	2.4	2.8

Summary of Calculated Solids Results
for
Versa Clean

Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Initial Blank	6886.7	1666.7
Detergent (100%)	24400.0	9550.0
Initial Detergent	7008.7	1714.5
Blank Control	7563.3	2166.7
Sterile Control	10090.0	2570.0
Detergent (After Incubation)	7013.3	1760.0

	Changes in Solids Concentration	
Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Blank Control – Initial Blank	676.6	500.0
Sterile Control – Initial Detergent	3081.3	855.6
Detergent (After Incubation) – Initial Detergent	4.6	45.5

SOLIDS REDUCTION

Date: 5/13/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 5.0 mL			
A	1.2837	1.3181	1.2942	6880.0	2100.0
B	1.2889	1.3244	1.2996	7100.0	2140.0
C	1.2839	1.3208	1.2950	7380.0	2220.0
			Average	7120.0	2153.3
			C.V.	2.9	2.3
Detergent:	EZE 240 (100%)	Sample Vol. 5.0 mL			
A	1.2788	1.4704	1.4409	38320.0	32420.0
B	1.2781	1.4704	1.4437	38460.0	33120.0
C	1.2810	1.5194	1.4540	47680.0	34600.0
			Average	41486.7	33380.0
			C.V.	10.6	2.7
Flask:	Blank Control	Sample Vol. 5.0 mL			
A	1.3041	1.3408	1.3160	7340.0	2380.0
B	1.3014	1.3383	1.3132	7380.0	2360.0
C	1.2953	1.3337	1.3075	7680.0	2440.0
D	1.2925	1.3419	1.3148	9880.0	4460.0
E	1.2982	1.3358	1.3100	7520.0	2360.0
F	1.2998	1.3331	1.3107	6660.0	2180.0
			Average	7316.0	2344.0
			C.V.	4.8	3.7
Detergent:	EZE 240 Sterile Control	Sample Vol. 5.0 mL			
A	1.2913	1.3520	1.3089	12140.0	3520.0
B	1.2960	1.3652	1.3193	13840.0	4660.0
C	1.2987	1.3654	1.3181	13340.0	3880.0
			Average	13106.7	4020.0
			C.V.	5.4	11.8
Detergent:	EZE 240	Sample Vol. 5.0 mL			
A	1.2935	1.3184	1.3012	4980.0	1540.0
B	1.2876	1.3122	1.2957	4920.0	1620.0
C	1.2839	1.3089	1.2914	5000.0	1500.0
			Average	4966.7	1553.3
			C.V.	0.7	3.2

Summary of Calculated Solids Results
for
EZE 240

Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Initial Blank	7120.0	2153.3
Detergent (100%)	41486.7	33380.0
Initial Detergent	7327.4	2320.2
Blank Control	7316.0	2344.0
Sterile Control	131065.7	4020.0
Detergent (After Incubation)	4966.7	1553.3

	Changes in Solids Concentration	
Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Blank Control – Initial Blank	196.0	190.7
Sterile Control – Initial Detergent	123738.3	1699.8
Detergent (After Incubation) – Initial Detergent	−2360.7	−766.9

SOLIDS REDUCTION

Date: 6/3/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 3.0 mL			
A	1.2820	1.3024	1.2881	6800.0	2033.3
B	1.2746	1.2947	1.2808	6700.0	2066.7
C	1.2815	1.3012	1.2873	6566.7	1933.3
			Average	6688.9	2011.1
			C.V.	1.4	2.8
Detergent:	Citranox (100%)	Sample Vol. 5.0 mL			
A	1.2786	2.0151	1.3076	147300.0	5800.0
B	1.2817	1.9928	1.2845	142220.0	560.0
C	1.2847	1.9962	1.4295	142300.0	28960.0
			Average	143940.0	11773.3
			C.V.	1.7	104.8
Flask:	Blank Control	Sample Vol. 3.0 mL			
A	1.2934	1.3127	1.2997	6433.3	2100.0
B	1.2932	1.3128	1.2996	6533.3	2133.3
C	1.2955	1.3148	1.3018	6433.3	2100.0
			Average	6466.7	2111.1
			C.V.	0.7	0.7
Flask:	Sterile Blank	Sample Vol. 3.0 mL			
A	1.2891	1.3155	1.2973	8800.0	2733.3
B	1.2877	1.3119	1.2953	8066.7	2533.3
C	1.2889	1.3140	1.2965	8366.7	2533.3
			Average	8411.1	2600.0
			C.V.	3.6	3.6
Detergent:	Citranox Sterile Control	Sample Vol. 3.0 mL			
A	1.2635	1.2968	1.2714	11100.0	2633.3
B	1.2632	1.2945	1.2739	10433.3	3566.7
C	1.2684	1.2998	1.2762	10466.7	2600.0
			Average	10666.7	2933.3
			C.V.	2.9	15.3
Detergent:	Citranox	Sample Vol. 3.0 mL			
A	1.2720	1.2966	1.2788	8200.0	2266.7
B	1.2782	1.3014	1.2844	7733.3	2066.7
C	1.2768	1.3000	1.2834	7733.3	2200.0
			Average	7888.9	2177.8
			C.V.	2.8	3.8

Summary of Calculated Solids Results
for
Citranox

Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Initial Blank	6688.9	2011.1
Detergent (100%)	143940.0	11533.3
Initial Detergent	7408.6	2068.8
Blank Control	6466.7	2111.1
Sterile Control	10666.7	2933.3
Detergent (After Incubation)	7888.9	2177.8

	Changes in Solids Concentration	
Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Blank Control – Initial Blank	−222.2	100.0
Sterile Control – Initial Detergent	3258.1	864.5
Detergent (After Incubation) – Initial Detergent	480.3	109.0

SOLIDS REDUCTION

Date: 6/3/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 3.0 mL			
A	1.2820	1.3024	1.2881	6800.0	2033.3
B	1.2746	1.2947	1.2808	6700.0	2066.7
C	1.2815	1.3012	1.2873	6566.7	1933.3
			Average	6688.9	2011.1
			C.V.	1.4	2.8
Detergent:	MSI 1025 (100%)	Sample Vol. 5.0 mL			
A	1.2852	1.6801	1.4903	78980.0	41020.0
B	1.2840	1.5748	1.4729	58160.0	37780.0
C	1.2817	1.6728	1.4731	78220.0	38280.0
			Average	71786.7	39026.7
			C.V.	13.4	3.6
Flask:	Blank Control	Sample Vol. 3.0 mL			
A	1.2934	1.3127	1.2997	6433.3	2100.0
B	1.2932	1.3128	1.2996	6533.3	2133.3
C	1.2955	1.3148	1.3018	6433.3	2100.0
			Average	6466.7	2111.1
			C.V.	0.7	0.7
Flask:	Sterile Blank	Sample Vol. 3.0 mL			
A	1.2891	1.3155	1.2973	8800.0	2733.3
B	1.2877	1.3119	1.2953	8066.7	2533.3
C	1.2889	1.3140	1.2965	8366.7	2533.3
			Average	8411.1	2600.0
			C.V.	3.6	3.6
Detergent:	MSI 1025 Sterile Control	Sample Vol. 3.0 mL			
A	1.2727	1.3011	1.2812	9466.7	2833.3
B	1.2724	1.3007	1.2804	9433.3	2666.7
C	1.2723	1.3012	1.2809	9633.3	2866.7
			Average	9511.1	2788.9
			C.V.	0.9	3.1
Detergent:	MSI 1025	Sample Vol. 3.0 mL			
A	1.2762	1.2974	1.2828	7066.7	2200.0
B	1.2761	1.2993	1.2851	7733.3	3000.0
C	1.2804	1.3024	1.2874	7333.3	2333.3
			Average	7377.8	2511.1
			C.V.	3.7	13.9

Summary of Calculated Solids Results
for
MSI 1025

Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Initial Blank	6688.9	2011.1
Detergent (100%)	71786.7	39026.7
Initial Detergent	7047.8	2206.2
Blank Control	6466.7	2111.1
Sterile Control	9511.1	2788.9
Detergent (After Incubation)	7377.8	2511.1

	Changes in Solids Concentration	
Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Blank Control – Initial Blank	−222.2	100.0
Sterile Control – Initial Detergent	2463.3	582.7
Detergent (After Incubation) – Initial Detergent	330.0	304.9

SOLIDS REDUCTION

Date: 5/27/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 5.0 mL			
A	1.2910	1.3262	1.3021	7040.0	2220.0
B	1.2900	1.3260	1.3010	7200.0	2200.0
C	1.2945	1.3302	1.3056	7140.0	2220.0
			Average	7126.7	2213.3
			C.V.	0.9	0.4
Detergent:	Ultraclean (100%)	Sample Vol. 2.0 mL			
A	1.2851	2.8086	2.7356	761750.0	725250.0
B	1.2808	2.8608	2.7975	790000.0	758350.0
C	1.2714	2.8001	2.7498	764350.0	739200.0
			Average	772033.3	740933.3
			C.V.	1.7	1.8
Flask:	Blank Control	Sample Vol. 3.0 mL			
A	1.2841	1.3149	1.2931	10266.7	3000.0
B	1.2882	1.3180	1.2967	9933.3	2833.3
C	1.2907	1.3121	1.2976	7133.3	2300.0
			Average	9111.1	2711.1
			C.V.	15.4	11.0
Flask:	Sterile Blank	Sample Vol. 3.0 mL			
A	1.2853	1.3131	1.2947	9266.7	3133.3
B	1.2857	1.3131	1.2935	9133.3	2600.0
C	1.2849	1.3109	1.2923	8666.7	2466.7
			Average	9022.2	2733.3
			C.V.	2.9	10.5
Detergent:	Ultraclean Sterile Control	Sample Vol. 3.0 mL			
A	1.2846	1.3360	1.3126	17133.3	9333.3
B	1.2860	1.3462	1.3178	20066.7	10600.0
C	1.2873	1.3631	1.3307	25266.7	14466.7
			Average	20822.2	11466.7
			C.V.	16.2	19.0
Detergent:	Ultraclean	Sample Vol. 3.0 mL			
A	1.2877	1.3392	1.3167	17166.7	9666.7
B	1.2892	1.3295	1.3096	13433.3	6800.0
C	1.2904	1.3375	1.3152	15700.0	8266.7
			Average	15433.3	8244.4
			C.V.	10.0	14.2

SOLIDS REDUCTION

Date: 6/3/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 3.0 mL			
A	1.2820	1.3024	1.2881	6800.0	2033.3
B	1.2746	1.2947	1.2808	6700.0	2066.7
C	1.2815	1.3012	1.2873	6566.7	1933.3
			Average	6688.9	2011.1
			C.V.	1.4	2.8
Detergent:	EZE 244 (100%)	Sample Vol. 5.0 mL			
A	1.2950	1.4569	1.3546	32380.0	11920.0
B	1.2895	1.4579	1.3545	33680.0	13000.0
C	1.2889	1.4532	1.3501	32860.0	12240.0
			Average	32973.3	12386.7
			C.V.	1.6	3.7
Flask:	Blank Control	Sample Vol. 3.0 mL			
A	1.2934	1.3127	1.2997	6433.3	2100.0
B	1.2932	1.3128	1.2996	6533.3	2133.3
C	1.2955	1.3148	1.3018	6433.3	2100.0
			Average	6466.7	2111.1
			C.V.	0.7	0.7
Flask:	Sterile Blank	Sample Vol. 3.0 mL			
A	1.2891	1.3155	1.2973	8800.0	2733.3
B	1.2877	1.3119	1.2953	8066.7	2533.3
C	1.2889	1.3140	1.2965	8366.7	2533.3
			Average	8411.1	2600.0
			C.V.	3.6	3.6
Detergent:	EZE 244 Sterile Control	Sample Vol. 3.0 mL			
A	1.2717	1.2984	1.2792	8900.0	2500.0
B	1.2774	1.3216	1.3050	14733.3	9200.0
C	1.2788	1.3057	1.2871	8966.7	2766.7
			Average	8933.3	2633.3
			C.V.	0.4	5.1
Detergent:	EZE 244	Sample Vol. 3.0 mL			
A	1.2850	1.3064	1.2915	7133.3	2166.7
B	1.2820	1.3032	1.2878	7066.7	1933.3
C	1.2785	1.3004	1.2848	7300.0	2100.0
			Average	7166.7	2066.7
			C.V.	1.4	4.7

Summary of Calculated Solids Results
for
EZE 244

Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Initial Blank	6688.9	2011.1
Detergent (100%)	32973.3	12386.7
Initial Detergent	6853.8	2073.0
Blank Control	6433.7	2111.1
Sterile Control	8933.4	2633.4
Detergent (After Incubation)	7166.7	2066.7

	Changes in Solids Concentration	
Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Blank Control – Initial Blank	−255.2	100.0
Sterile Control – Initial Detergent	2079.6	560.3
Detergent (After Incubation) – Initial Detergent	312.9	−6.3

SOLIDS REDUCTION

Date: 5/27/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 5.0 mL			
A	1.2910	1.3262	1.3021	7040.0	2220.0
B	1.2900	1.3260	1.3010	7200.0	2200.0
C	1.2945	1.3302	1.3056	7140.0	2220.0
			Average	7126.7	2213.3
			C.V.	0.9	0.4
Detergent:	Intex 8284 (100%)	Sample Vol. 5.0 mL			
A	1.2893	1.5435	1.4004	50840.0	22220.0
B	1.2919	1.4684	1.4037	35300.0	22360.0
C	1.2861	1.4753	1.3993	37840.0	22640.0
			Average	41326.7	22406.7
			C.V.	16.5	0.8
Flask:	Blank Control	Sample Vol. 3.0 mL			
A	1.2841	1.3149	1.2931	10266.7	3000.0
B	1.2882	1.3180	1.2967	9933.3	2833.3
C	1.2907	1.3121	1.2976	7133.3	2300.0
			Average	9111.1	2711.1
			C.V.	15.4	11.0
Flask:	Sterile Blank	Sample Vol. 3.0 mL			
A	1.2853	1.3131	1.2947	9266.7	3133.3
B	1.2857	1.3131	1.2935	9133.3	2600.0
C	1.2849	1.3109	1.2923	8666.7	2466.7
			Average	9022.2	2733.3
			C.V.	2.9	10.5
Detergent:	Intex 8284 Sterile Control	Sample Vol. 3.0 mL			
A	1.2831	1.3150	1.2922	10633.3	3033.3
B	1.2804	1.3149	1.2898	11500.0	3133.3
C	1.2810	1.3157	1.2984	11566.7	5800.0
			Average	11233.3	3988.9
			C.V.	3.8	32.1
Detergent:	Intex 8284	Sample Vol. 3.0 mL			
A	1.2927	1.3148	1.3004	7366.7	2566.7
B	1.2883	1.3108	1.2959	7500.0	2533.3
C	1.2903	1.3145	1.3002	8066.7	3300.0
			Average	7644.4	2800.0
			C.V.	4.0	12.6

Summary of Calculated Solids Results
for
Intex 8284

Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Initial Blank	7126.7	2213.3
Detergent (100%)	41326.7	22406.7
Initial Detergent	7333.3	2325.3
Blank Control	9111.1	2711.1
Sterile Control	11233.3	3988.9
Detergent (After Incubation)	7644.4	2800.0

	Changes in Solids Concentration	
Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Blank Control – Initial Blank	1984.4	497.8
Sterile Control – Initial Detergent	3900.0	1663.6
Detergent (After Incubation) – Initial Detergent	311.1	474.7

SOLIDS REDUCTION

Date: 5/11/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 5.0 mL			
A	1.3650	1.3989	1.3733	6780.0	1660.0
B	1.3698	1.4025	1.3776	6540.0	1560.0
C	1.3679	1.4046	1.3768	7340.0	1780.0
			Average	6886.7	1666.7
			C.V.	4.9	5.4
Detergent:	Simple Green (100%)	Sample Vol. 5.0 mL			
A	1.2927	1.4918	1.4296	39820.0	27380.0
B	1.2941	1.4895	1.4436	39080.0	29900.0
C	1.2934	1.4888	1.4373	39080.0	28780.0
			Average	39326.7	28686.7
			C.V.	0.9	3.6
Flask:	Blank Control	Sample Vol. 5.0 mL			
A	1.3555	1.3943	1.3667	7760.0	2240.0
B	1.3559	1.3944	1.3670	7700.0	2220.0
C	1.3584	1.3976	1.3696	7840.0	2240.0
D	1.3595	1.3983	1.3707	7760.0	2240.0
E	1.3677	1.4059	1.3786	7640.0	2180.0
F	1.3699	1.4033	1.3793	6680.0	1880.0
			Average	7563.3	2166.7
			C.V.	5.3	6.0
Detergent:	Simple Green Sterile Control	Sample Vol. 5.0 mL			
A	1.3696	1.4102	1.3803	8120.0	2140.0
B	1.3545	1.3981	1.3665	8720.0	2400.0
C	1.3693	1.4046	1.3789	7060.0	1920.0
			Average	7966.7	2153.3
			C.V.	8.6	9.1
Detergent:	Simple Green	Sample Vol. 5.0 mL			
A	1.3669	1.4041	1.3766	7440.0	1940.0
B	1.3669	1.4040	1.3764	7420.0	1900.0
C	1.3615	1.3976	1.3710	7220.0	1900.0
			Average	7360.0	1913.3
			C.V.	1.3	1.0

Summary of Calculated Solids Results
for
Simple Green

Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Initial Blank	6886.7	1666.7
Detergent (100%)	39326.7	28686.7
Initial Detergent	7083.3	1810.1
Blank Control	7563.3	2166.7
Sterile Control	7966.7	2153.3
Detergent (After Incubation)	7360.0	1913.0

	Changes in Solids Concentration	
Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Blank Control – Initial Blank	676.6	500.0
Sterile Control – Initial Detergent	883.4	343.2
Detergent (After Incubation) – Initial Detergent	276.7	102.9

SOLIDS REDUCTION

Date: 5/20/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 5.0 mL			
A	1.2900	1.3236	1.3005	6720.0	2100.0
B	1.2875	1.3187	1.2974	6240.0	1980.0
C	1.2913	1.3242	1.3008	6580.0	1900.0
			Average	6513.3	1993.3
			C.V.	3.1	4.1
Detergent:	815 QR (100%)	Sample Vol. 5.0 mL			
A	1.2892	1.9659	1.6931	135340.0	80780.0
B	1.2860	1.9964	1.7225	142080.0	87300.0
C	1.2855	2.0253	1.7207	147960.0	87040.0
			Average	141793.3	85040.0
			C.V.	3.6	3.5
Flask:	Blank Control	Sample Vol. 5.0 mL			
A	1.2901	1.3218	1.2998	6340.0	1940.0
B	1.2878	1.3199	1.2978	6420.0	2000.0
C	1.2932	1.3244	1.3029	6240.0	1940.0
			Average	6333.3	1960.0
			C.V.	1.2	1.4
Flask:	Sterile Blank	Sample Vol. 5.0 mL			
A	1.2873	1.3278	1.3000	8100.0	2540.0
B	1.2903	1.3287	1.3015	7680.0	2240.0
C	1.2898	1.3279	1.3015	7620.0	2340.0
			Average	7800.0	2373.3
			C.V.	2.7	5.3
Detergent:	815 QR Sterile Control	Sample Vol. 4.0 mL			
A	1.2938	1.3291	1.3044	8825.0	2650.0
B	1.2926	1.3302	1.3036	9400.0	2750.0
C	1.2808	1.3166	1.2919	8950.0	2775.0
			Average	9058.3	2725.0
			C.V.	2.7	2.0
Detergent:	815 QR	Sample Vol. 5.0 mL			
A	1.2960	1.3345	1.3085	7700.0	2500.0
B	1.2836	1.3201	1.2952	7300.0	2320.0
C	1.2890	1.3259	1.3008	7380.0	2360.0
			Average	7460.0	2393.3
			C.V.	2.3	3.2

Summary of Calculated Solids Results
for
815 QR

Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Initial Blank	6513.3	1993.3
Detergent (100%)	141793.3	85040.0
Initial Detergent	7222.3	2418.5
Blank Control	6333.3	1960.0
Sterile Control	9058.3	2725.0
Detergent (After Incubation)	7460.0	2393.0

	Changes in Solids Concentration	
Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Blank Control – Initial Blank	−180.0	−33.3
Sterile Control – Initial Detergent	1836.0	306.5
Detergent (After Incubation) – Initial Detergent	237.7	−25.5

SOLIDS REDUCTION

Date: 5/13/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 5.0 mL			
A	1.2837	1.3181	1.2942	6880.0	2100.0
B	1.2889	1.3244	1.2996	7100.0	2140.0
C	1.2839	1.3208	1.2950	7380.0	2220.0
			Average	7120.0	2153.3
			C.V.	2.9	2.3
Detergent:	Aqua #1 (100%)	Sample Vol. 5.0 mL			
A	1.2879	1.8593	1.7426	114280.0	90940.0
B	1.2871	1.8662	1.7440	115820.0	91380.0
C	1.2822	1.8457	1.7351	112700.0	90580.0
			Average	114266.7	90966.7
			C.V.	1.1	0.4
Flask:	Blank Control	Sample Vol. 5.0 mL			
A	1.3041	1.3408	1.3160	7340.0	2380.0
B	1.3014	1.3383	1.3132	7380.0	2360.0
C	1.2953	1.3337	1.3075	7680.0	2440.0
D	1.2925	1.3419	1.3148	9880.0	4460.0
E	1.2982	1.3358	1.3100	7520.0	2360.0
F	1.2998	1.3331	1.3107	6660.0	2180.0
			Average	7316.0	2344.0
			C.V.	4.8	3.7
Detergent:	Aqua #1 Sterile Control	Sample Vol. 5.0 mL			
A	1.2918	1.3515	1.3116	11940.0	3960.0
B	1.2902	1.3501	1.3102	11980.0	4000.0
C	1.2925	1.3555	1.3135	12600.0	4200.0
			Average	12173.3	4053.3
			C.V.	2.5	2.6
Detergent:	Aqua #1	Sample Vol. 5.0 mL			
A	1.2970	1.3214	1.3057	4880.0	1740.0
B	1.2946	1.3193	1.3044	4940.0	1960.0
C	1.2968	1.3216	1.3055	4960.0	1740.0
			Average	4926.7	1813.3
			C.V.	0.7	5.7

Summary of Calculated Solids Results
for
Aqua #1

Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Initial Blank	7120.0	2153.3
Detergent (100%)	114266.7	90966.7
Initial Detergent	7691.3	2608.1
Blank Control	7316.0	2344.0
Sterile Control	12173.3	4053.3
Detergent (After Incubation)	4926.7	1813.3

	Changes in Solids Concentration	
Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Blank Control – Initial Blank	196.0	190.7
Sterile Control – Initial Detergent	4482.0	1445.2
Detergent (After Incubation) – Initial Detergent	−2764.6	−794.8

SOLIDS REDUCTION

Date: 5/13/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 5.0 mL			
A	1.2837	1.3181	1.2942	6880.0	2100.0
B	1.2889	1.3244	1.2996	7100.0	2140.0
C	1.2839	1.3208	1.2950	7380.0	2220.0
			Average	7120.0	2153.3
			C.V.	2.9	2.3
Detergent:	Hurri-Safe (100%)	Sample Vol. 5.0 mL			
A	1.2783	1.7178	1.5461	87900.0	53560.0
B	1.2795	No Sample	No Sample	No Sample	No Sample
C	1.2829	1.7159	1.5521	86600.0	53840.0
			Average	87250.0	53700.0
			C.V.	0.7	0.3
Flask:	Blank Control	Sample Vol. 5.0 mL			
A	1.3041	1.3408	1.3160	7340.0	2380.0
B	1.3014	1.3383	1.3132	7380.0	2360.0
C	1.2953	1.3337	1.3075	7680.0	2440.0
D	1.2925	1.3419	1.3148	9880.0	4460.0
E	1.2982	1.3358	1.3100	7520.0	2360.0
F	1.2998	1.3331	1.3107	6660.0	2180.0
			Average	7316.0	2344.0
			C.V.	4.8	3.7
Detergent:	Hurri-Safe Sterile Control	Sample Vol. 5.0 mL			
A	1.2818	1.3138	1.2919	6400.0	2020.0
B	1.2868	1.3481	1.3055	12260.0	3740.0
C	1.2917	1.3649	1.3138	14640.0	4420.0
			Average	13450.0	4080.0
			C.V.	8.8	8.3
Detergent:	Hurri-Safe	Sample Vol. 5.0 mL			
A	1.3033	1.3306	1.3119	5460.0	1720.0
B	1.2973	1.3247	1.3050	5480.0	1540.0
C	1.2981	1.3191	1.3049	4200.0	1360.0
			Average	5046.7	1540.0
			C.V.	11.9	9.5

Summary of Calculated Solids Results
for
Hurri-Safe

Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Initial Blank	7120.0	2153.3
Detergent (100%)	87250	53700.0
Initial Detergent	7556.3	2421.8
Blank Control	7316.0	2344.0
Sterile Control	13450.0	4080.0
Detergent (After Incubation)	5046.7	1540.0

	Changes in Solids Concentration	
Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Blank Control – Initial Blank	196.0	190.7
Sterile Control – Initial Detergent	5893.8	1658.2
Detergent (After Incubation) – Initial Detergent	−2509.6	−881.8

SOLIDS REDUCTION

Date: 5/20/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 5.0 mL			
A	1.2900	1.3236	1.3005	6720.0	2100.0
B	1.2875	1.3187	1.2974	6240.0	1980.0
C	1.2913	1.3242	1.3008	6580.0	1900.0
			Average	6513.3	1993.3
			C.V.	3.1	4.1
Detergent:	MA-102 (100%)	Sample Vol. 5.0 mL			
A	1.2854	1.4232	1.3265	27560.0	8220.0
B	1.2886	1.4887	1.3270	40020.0	7680.0
C	1.2899	1.3834	1.3303	18700.0	8080.0
			Average	28760.0	7993.3
			C.V.	30.4	2.9
Flask:	Blank Control	Sample Vol. 5.0 mL			
A	1.2901	1.3218	1.2998	6340.0	1940.0
B	1.2878	1.3199	1.2978	6420.0	2000.0
C	1.2932	1.3244	1.3029	6240.0	1940.0
			Average	6333.3	1960.0
			C.V.	1.2	1.4
Flask:	Sterile Blank	Sample Vol. 5.0 mL			
A	1.2873	1.3278	1.3000	8100.0	2540.0
B	1.2903	1.3287	1.3015	7680.0	2240.0
C	1.2898	1.3279	1.3015	7620.0	2340.0
			Average	7800.0	2373.3
			C.V.	2.7	5.3
Detergent:	MA-102 Sterile Control	Sample Vol. 4.0 mL			
A	1.2817	1.3222	1.2922	10125.0	2625.0
B	1.2823	1.3193	1.2917	9250.0	2350.0
C	1.2839	1.3189	1.2930	8750.0	2275.0
			Average	9375.0	2416.7
			C.V.	6.1	6.2
Detergent:	MA-102	Sample Vol. 5.0 mL			
A	1.2891	1.3256	1.2996	7300.0	2100.0
B	1.2937	1.3296	1.3037	7180.0	2000.0
C	1.2926	1.3272	1.3054	6920.0	2560.0
			Average	7133.3	2220.0
			C.V.	2.2	11.0

Summary of Calculated Solids Results
for
MA–102

Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Initial Blank	6513.3	1993.3
Detergent (100%)	28760	7993.3
Initial Detergent	6657.1	2033.3
Blank Control	6333.3	1960.0
Sterile Control	9375.0	2416.7
Detergent (After Incubation)	7133.3	2220.0

	Changes in Solids Concentration	
Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Blank Control – Initial Blank	–180.0	–33.3
Sterile Control – Initial Detergent	2717.9	383.4
Detergent (After Incubation) – Initial Detergent	476.2	186.7

SOLIDS REDUCTION

Date: 5/11/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 5.0 mL			
A	1.3650	1.3989	1.3733	6780.0	1660.0
B	1.3698	1.4025	1.3776	6540.0	1560.0
C	1.3679	1.4046	1.3768	7340.0	1780.0
			Average	6886.7	1666.7
			C.V.	4.9	5.4
Detergent:	Cavi–Clean (100%)	Sample Vol. 5.0 mL			
A	1.2912	2.0699	1.5076	155740.0	43280.0
B	1.2870	2.1979	1.5971	182180.0	62020.0
C	1.2863	2.1069	1.5219	164120.0	47120.0
			Average	167346.7	50806.7
			C.V.	6.6	15.9
Flask:	Blank Control	Sample Vol. 5.0 mL			
A	1.3555	1.3943	1.3667	7760.0	2240.0
B	1.3559	1.3944	1.3670	7700.0	2220.0
C	1.3584	1.3976	1.3696	7840.0	2240.0
D	1.3595	1.3983	1.3707	7760.0	2240.0
E	1.3677	1.4059	1.3786	7640.0	2180.0
F	1.3699	1.4033	1.3793	6680.0	1880.0
			Average	7563.3	2166.7
			C.V.	5.3	6.0
Detergent:	Cavi–Clean Sterile Control	Sample Vol. 5.0 mL			
A	1.3568	1.3959	1.3668	7820.0	2000.0
B	1.3553	1.3968	1.3663	8300.0	2200.0
C	1.3547	1.3964	1.3654	8340.0	2140.0
			Average	8153.3	2113.3
			C.V.	2.9	4.0
Detergent:	Cavi–Clean	Sample Vol. 5.0 mL			
A	1.3624	1.3984	1.3712	7200.0	1760.0
B	1.3632	1.3964	1.3713	6640.0	1620.0
C	1.3646	1.3980	1.3727	6680.0	1620.0
			Average	6840.0	1666.7
			C.V.	3.7	4.0

Summary of Calculated Solids Results
for
Cavi–Clean

Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Initial Blank	6886.7	1666.7
Detergent (100%)	167646.7	50806.7
Initial Detergent	7724.9	1920.7
Blank Control	7563.3	2166.7
Sterile Control	8153.3	2113.3
Detergent (After Incubation)	6840.0	1666.7

	Changes in Solids Concentration	
Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Blank Control – Initial Blank	676.6	500.0
Sterile Control – Initial Detergent	428.4	192.6
Detergent (After Incubation) – Initial Detergent	−884.9	−254.0

SOLIDS REDUCTION

Date: 5/20/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 5.0 mL			
A	1.2900	1.3236	1.3005	6720.0	2100.0
B	1.2875	1.3187	1.2974	6240.0	1980.0
C	1.2913	1.3242	1.3008	6580.0	1900.0
			Average	6513.3	1993.3
			C.V.	3.1	4.1
Detergent:	Triton X-100 (100%)	Sample Vol. 5.0 mL			
A	1.2849	1.7293	1.2984	88880.0	2700.0
B	1.2834	2.7847	1.3107	300260.0	5460.0
C	1.2751	1.8845	1.3155	117880.0	8080.0
			Average	169006.7	5413.3
			C.V.	55.4	40.6
Flask:	Blank Control	Sample Vol. 5.0 mL			
A	1.2901	1.3218	1.2998	6340.0	1940.0
B	1.2878	1.3199	1.2978	6420.0	2000.0
C	1.2932	1.3244	1.3029	6240.0	1940.0
			Average	6333.3	1960.0
			C.V.	1.2	1.4
Flask:	Sterile Blank	Sample Vol. 5.0 mL			
A	1.2873	1.3278	1.3000	8100.0	2540.0
B	1.2903	1.3287	1.3015	7680.0	2240.0
C	1.2898	1.3279	1.3015	7620.0	2340.0
			Average	7800.0	2373.3
			C.V.	2.7	5.3
Detergent:	Triton X-100 Sterile Control	Sample Vol. 4.0 mL			
A	1.2887	1.3833	1.2982	23650.0	2375.0
B	1.2897	1.3726	1.2994	20725.0	2425.0
C	1.2894	1.3652	1.2992	18950.0	2450.0
			Average	21108.3	2416.7
			C.V.	9.2	1.3
Detergent:	Triton X-100	Sample Vol. 5.0 mL			
A	1.2796	1.3499	1.2884	14060.0	1760.0
B	1.2790	1.3632	1.2910	16840.0	2400.0
C	1.2840	1.3563	1.2958	14460.0	2360.0
			Average	15120.0	2173.3
			C.V.	8.1	13.5

Summary of Calculated Solids Results
for
Triton X−100

Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Initial Blank	6513.3	1993.3
Detergent (100%)	169006.7	5413.3
Initial Detergent	7358.3	2020.4
Blank Control	6333.3	1960.0
Sterile Control	16886.7	1933.3
Detergent (After Incubation)	15120.0	2173.3

	Changes in Solids Concentration	
Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Blank Control − Initial Blank	−180.0	−33.3
Sterile Control − Initial Detergent	9528.4	−87.1
Detergent (After Incubation) − Initial Detergent	7761.7	152.9

SOLIDS REDUCTION

Date: 5/13/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 5.0 mL			
A	1.2837	1.3181	1.2942	6880.0	2100.0
B	1.2889	1.3244	1.2996	7100.0	2140.0
C	1.2839	1.3208	1.2950	7380.0	2220.0
			Average	7120.0	2153.3
			C.V.	2.9	2.3
Detergent:	Kyzen X-20-11 (100%)	Sample Vol. 5.0 mL			
A	1.2832	1.2984	1.2853	3040.0	420.0
B	1.2763	1.2973	1.2780	4200.0	340.0
C	1.2688	1.2957	1.2722	5380.0	680.0
			Average	4206.7	480.0
			C.V.	22.7	30.2
Flask:	Blank Control	Sample Vol. 5.0 mL			
A	1.3041	1.3408	1.3160	7340.0	2380.0
B	1.3014	1.3383	1.3132	7380.0	2360.0
C	1.2953	1.3337	1.3075	7680.0	2440.0
D	1.2925	1.3419	1.3148	9880.0	4460.0
E	1.2982	1.3358	1.3100	7520.0	2360.0
F	1.2998	1.3331	1.3107	6660.0	2180.0
			Average	7316.0	2344.0
			C.V.	4.8	3.7
Detergent:	Kyzen X-20-11 Sterile Control	Sample Vol. 5.0 mL			
A	1.3008	1.3604	1.3181	11920.0	3460.0
B	1.2999	1.3526	1.3181	10540.0	3640.0
C	1.3007	1.3574	1.3153	11340.0	2920.0
			Average	11266.7	3340.0
			C.V.	5.0	9.2
Detergent:	Kyzen X-20-11	Sample Vol. 5.0 mL			
A	1.2851	1.3119	1.2927	5360.0	1520.0
B	1.2865	1.3121	1.2936	5120.0	1420.0
C	1.2836	1.3075	1.2914	4780.0	1560.0
			Average	5086.7	1500.0
			C.V.	4.7	3.9

Summary of Calculated Solids Results
for
Kyzen X-20-11

Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Initial Blank	7120.0	2153.3
Detergent (100%)	4206.7	480.0
Initial Detergent	7141.0	2155.7
Blank Control	7316.0	2344.0
Sterile Control	11266.7	3340.0
Detergent (After Incubation)	5086.7	1500.0

	Changes in Solids Concentration	
Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Blank Control – Initial Blank	196.0	190.7
Sterile Control – Initial Detergent	4125.7	1184.3
Detergent (After Incubation) – Initial Detergent	−2054.3	−655.7

SOLIDS REDUCTION

Date: 5/27/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 5.0 mL			
A	1.2910	1.3262	1.3021	7040.0	2220.0
B	1.2900	1.3260	1.3010	7200.0	2200.0
C	1.2945	1.3302	1.3056	7140.0	2220.0
			Average	7126.7	2213.3
			C.V.	0.9	0.4
Detergent:	Oakite X-91-5 (100%)	Sample Vol. 5.0 mL			
A	1.2635	1.3841	1.3355	24120.0	14400.0
B	1.2659	1.3844	1.3365	23700.0	14120.0
C	1.2704	1.4363	1.3257	33180.0	11060.0
			Average	27000.0	13193.3
			C.V.	16.2	11.5
Flask:	Blank Control	Sample Vol. 3.0 mL			
A	1.2841	1.3149	1.2931	10266.7	3000.0
B	1.2882	1.3180	1.2967	9933.3	2833.3
C	1.2907	1.3121	1.2976	7133.3	2300.0
			Average	9111.1	2711.1
			C.V.	15.4	11.0
Flask:	Sterile Blank	Sample Vol. 3.0 mL			
A	1.2853	1.3131	1.2947	9266.7	3133.3
B	1.2857	1.3131	1.2935	9133.3	2600.0
C	1.2849	1.3109	1.2923	8666.7	2466.7
			Average	9022.2	2733.3
			C.V.	2.9	10.5
Detergent:	Oakite X-91-5 Sterile Control	Sample Vol. 3.0 mL			
A	1.2800	1.3140	1.2896	11333.3	3200.0
B	1.2826	1.3188	1.2932	12066.7	3533.3
C	1.2841	1.3165	1.2935	10800.0	3133.3
			Average	11400.0	3288.9
			C.V.	4.6	5.3
Detergent:	Oakite X-91-5	Sample Vol. 3.0 mL			
A	1.2950	1.3174	1.3026	7466.7	2533.3
B	1.2854	1.3078	1.2923	7466.7	2300.0
C	1.2860	1.3056	1.2921	6533.3	2033.3
			Average	7155.6	2288.9
			C.V.	6.1	8.9

Summary of Calculated Solids Results
for
Oakite X–91–5

Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Initial Blank	7126.7	2213.3
Detergent (100%)	27000	13193.3
Initial Detergent	7261.7	2279.3
Blank Control	9111.1	2711.1
Sterile Control	11400.0	3288.9
Detergent (After Incubation)	7155.6	2288.9

	Changes in Solids Concentration	
Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Blank Control – Initial Blank	1984.4	497.8
Sterile Control – Initial Detergent	4138.3	1009.6
Detergent (After Incubation) – Initial Detergent	–106.1	9.6

SOLIDS REDUCTION

Date: 5/27/93

Replicate	Dish Wt. (g)	Dish & Sample Wt. (105 C) (g)	Dish & Sample Wt. (550 C) (g)	Total Solids (mg/L)	Volatile Solids (mg/L)
Flask:	Initial Blank	Sample Vol. 5.0 mL			
A	1.2910	1.3262	1.3021	7040.0	2220.0
B	1.2900	1.3260	1.3010	7200.0	2200.0
C	1.2945	1.3302	1.3056	7140.0	2220.0
			Average	7126.7	2213.3
			C.V.	0.9	0.4
Detergent:	PF Degreaser (100%)	Sample Vol. 5.0 mL			
A	1.2742	1.2844	1.2767	2040.0	500.0
B	1.2760	1.2777	1.2764	340.0	80.0
C	1.2787	1.2797	1.2788	200.0	20.0
			Average	860.0	200.0
			C.V.	97.2	106.8
Flask:	Blank Control	Sample Vol. 3.0 mL			
A	1.2841	1.3149	1.2931	10266.7	3000.0
B	1.2882	1.3180	1.2967	9933.3	2833.3
C	1.2907	1.3121	1.2976	7133.3	2300.0
			Average	9111.1	2711.1
			C.V.	15.4	11.0
Flask:	Sterile Blank	Sample Vol. 3.0 mL			
A	1.2853	1.3131	1.2947	9266.7	3133.3
B	1.2857	1.3131	1.2935	9133.3	2600.0
C	1.2849	1.3109	1.2923	8666.7	2466.7
			Average	9022.2	2733.3
			C.V.	2.9	10.5
Detergent:	PF Degreaser Sterile Control	Sample Vol. 3.0 mL			
A	1.2804	1.3101	1.2914	9900.0	3666.7
B	1.2818	1.3076	1.2893	8600.0	2500.0
C	1.2851	1.3114	1.2926	8766.7	2500.0
			Average	9088.9	2888.9
			C.V.	6.4	19.0
Detergent:	PF Degreaser	Sample Vol. 3.0 mL			
A	1.2901	1.3121	1.2980	7333.3	2633.3
B	1.2890	1.3116	1.2959	7533.3	2300.0
C	1.2845	1.3056	1.2917	7033.3	2400.0
			Average	7300.0	2444.4
			C.V.	2.8	5.7

Summary of Calculated Solids Results
for
PF Degreaser

Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Initial Blank	7126.7	2213.3
Detergent (100%)	270	50.0
Initial Detergent	7128.1	2213.6
Blank Control	9111.1	2711.1
Sterile Control	9088.9	2888.9
Detergent (After Incubation)	7300.0	2444.4

	Changes in Solids Concentration	
Sample	Total Solids (mg/L)	Volatile Solids (mg/L)
Blank Control – Initial Blank	1984.4	497.8
Sterile Control – Initial Detergent	1960.8	675.4
Detergent (After Incubation) – Initial Detergent	171.9	230.8

APPENDIX C
PHASE III. BENCH-SCALE ACTIVATED SLUDGE STUDY DATA

Appendix C

Phase III. Bench-Scale Activated Sludge Study Data

The data contained in the following tables are the results from laboratory experiments conducted to examine how the addition of two washwater types might impact the Heath WWTP. These data were used to calculate the data reported in the body of this report. The parameters that were measured included both total and volatile solids and COD. The COD data are the direct readout from the spectrophotometer corrected by any dilution factor. The volatile solids values were calculated as follows.

Sample: Reactor 1 at Time 0 for Replicate A.

$$Total\ Solids\ (mg/L) = \frac{(Dish\ \&\ Sample\ Wt.(103^{\circ}C)(grams)\ -Dish\ Wt.(grams))\ X\ \frac{1000\,mg}{1gram}}{Sample\ Volume(mL)}\ X\ \frac{1000\,mL}{1L}$$

$$Total Solids(mg/L) = \frac{(1.2941g - 1.2881g) + 1000}{5\,mL} X 1000$$

$$Total Solids(mg/L) = 1{,}200(mg/L)$$

$$Volatile Solids(mg/L) = Total Solids(mg/L) - \frac{Dish\&Sample\ Wt.(105^{\circ}C)(grams) - Dish\&Sample\ Wt.(550^{\circ}C)(grams)\ X\frac{1000\,mg}{1gram}}{Sample\ Volume(mL)}\ X\frac{1000\,mL}{1L}$$

$$Volatile Solids(mg/L) = 1{,}200(mg/L) - \frac{(1.2941 - 1.2914) X 1000}{5mL} X 1000$$

$$Volatile Solids(mg/L) = 660(mg/L)$$

SOLIDS REDUCTION & COD (PHASE #3)

Date: 6/15/93
Reactor#1 Detergent: **10 mL Brulin 815 GD (detergent = 0.053% [vol/vol])**
Reactor#2 Control
Reactor#3 Detergent: **10 mL Versa Clean (detergent = 0.053% [vol/vol])**

Sample Vol: 5.0 mL

Incubation time frame: (Before Detergent Injection)

		Dish Wt. (g)	Dish & Sample Wt.(105 C)	Dish & Sample Wt.(550 C)	Total Solids (mg/L)	Volatile Solids (mg/L)	COD (mg/L)
Reactor#1	**Replicate**						
	A	1.2881	1.2941	1.2914	1200.0	660.0	28.0
	B	1.2874	1.2932	1.2929	1160.0	1100.0	27.0
	C	1.2870	1.2926	1.2908	1120.0	760.0	28.0
Reactor#2	**Replicate**						
	A	1.2881	1.2936	1.2913	1100.0	640.0	18.0
	B	1.2870	1.2927	1.2899	1140.0	580.0	18.0
	C	1.2833	1.2889	1.2861	1120.0	560.0	18.0
Reactor#3	**Replicate**						
	A	1.2855	1.2906	1.2888	1020.0	660.0	23.0
	B	1.2886	1.2940	1.2920	1080.0	680.0	21.0
	C	1.2911	1.2970	1.2948	1180.0	740.0	21.0
			Reactor#1 Avg.		1160.0	840.0	27.7
			C.V		2.8	22.4	1.7
			Reactor#2 Avg.		1120.0	593.3	18.0
			C.V.		1.5	5.7	0.0
			Reactor#3 Avg.		1093.3	693.3	21.7
			C.V.		6.0	4.9	4.4

SOLIDS REDUCTION & COD (PHASE #3)

Date: 6/15/93
Reactor#1 Detergent: **10 mL Brulin 815 GD (detergent = 0.053% [vol/vol])**
Reactor#2 Control
Reactor#3 Detergent: **10 mL Versa Clean (detergent = 0.053% [vol/vol])**

Incubation time frame: (Time of Detergent Injection)

		Dish Wt. (g)	Dish & Sample Wt.(105 C)	Dish & Sample Wt.(550 C)	Total Solids (mg/L)	Volatile Solids (mg/L)	COD (mg/L)
Reactor#1	**Replicate**						
	A	1.2901	1.2953	1.2937	1040.0	720.0	38.0
	B	1.2854	1.2908	1.2888	1080.0	680.0	40.0
	C	1.2769	1.2825	1.2808	1120.0	780.0	40.0
Reactor#2	**Replicate**						
	A	1.2779	1.2837	1.2817	1160.0	760.0	NA
	B	1.2865	1.2922	1.2902	1140.0	740.0	NA
	C	1.2794	1.2857	1.2829	1260.0	700.0	NA
Reactor#3	**Replicate**						
	A	1.2893	1.2951	1.2931	1160.0	760.0	24.0
	B	1.2888	1.2945	1.2924	1140.0	720.0	25.0
	C	1.2738	1.2795	1.2774	1140.0	720.0	29.0
			Reactor#1	Avg.	1080.0	726.7	39.3
				C.V	3.0	5.7	2.4
			Reactor#2	Avg.	1186.7	733.3	NA
				C.V.	4.4	3.4	NA
			Reactor#3	Avg.	1146.7	733.3	26.0
				C.V.	0.8	2.6	8.3

SOLIDS REDUCTION & COD (PHASE #3)

Date: 6/15/93
Reactor#1 Detergent: **10 mL Brulin 815 GD (detergent = 0.053% [vol/vol])**
Reactor#2 Control
Reactor#3 Detergent: **10 mL Versa Clean (detergent = 0.053% [vol/vol])**

Incubation time frame: (1 Hour After Detergent Injection)

		Dish Wt. (g)	Dish & Sample Wt.(105 C)	Dish & Sample Wt.(550 C)	Total Solids (mg/L)	Volatile Solids (mg/L)	COD (mg/L)
Reactor#1	**Replicate**						
	A	1.2828	1.2882	1.2862	1080.0	680.0	29.0
	B	1.2808	1.2855	1.2838	940.0	600.0	31.0
	C	1.2771	1.2825	1.2806	1080.0	700.0	27.0
Reactor#2	**Replicate**						
	A	1.2754	1.2817	1.2790	1260.0	720.0	23.0
	B	1.2685	1.2751	1.2723	1320.0	760.0	23.0
	C	1.2631	1.2693	1.2664	1240.0	660.0	22.0
Reactor#3	**Replicate**						
	A	1.2770	1.2824	1.2803	1080.0	660.0	23.0
	B	1.2837	1.2891	1.2873	1080.0	720.0	27.0
	C	1.2845	1.2895	1.2875	1000.0	600.0	24.0
			Reactor#1 Avg.		1033.3	660.0	29.0
			C.V		6.4	6.5	5.6
			Reactor#2 Avg.		1273.3	713.3	22.7
			C.V.		2.7	5.8	2.1
			Reactor#3 Avg.		1053.3	660.0	24.7
			C.V.		3.6	7.4	6.9

SOLIDS REDUCTION & COD (PHASE #3)

Date: 6/15/93
Reactor#1 Detergent: **10 mL Brulin 815 GD (detergent = 0.053% [vol/vol])**
Reactor#2 Control
Reactor#3 Detergent: **10 mL Versa Clean (detergent = 0.053% [vol/vol])**

Incubation time frame: (3 Hours After Detergent Injection)

		Dish Wt. (g)	Dish & Sample Wt.(105 C)	Dish & Sample Wt.(550 C)	Total Solids (mg/L)	Volatile Solids (mg/L)	COD (mg/L)
Reactor#1	**Replicate**						
	A	1.2652	1.2705	1.2689	1060.0	740.0	23.0
	B	1.2691	1.2745	1.2727	1080.0	720.0	20.0
	C	1.2788	1.2839	1.2822	1020.0	680.0	22.0
Reactor#2	**Replicate**						
	A	1.2724	1.2776	1.2748	1040.0	480.0	20.0
	B	1.2651	1.2707	1.2685	1120.0	680.0	17.0
	C	1.2747	1.2799	1.2774	1040.0	540.0	21.0
Reactor#3	**Replicate**						
	A	1.2613	1.2676	1.2651	1260.0	760.0	18.0
	B	1.2600	1.2648	1.2632	960.0	640.0	22.0
	C	1.2612	1.2658	1.2642	920.0	600.0	20.0
			Reactor#1	Avg.	1053.3	713.3	21.7
				C.V	2.4	3.5	5.8
			Reactor#2	Avg.	1066.7	566.7	19.3
				C.V.	3.5	14.8	8.8
			Reactor#3	Avg.	1046.7	666.7	20.0
				C.V.	14.5	10.2	8.2

SOLIDS REDUCTION & COD (PHASE #3)

Date: 6/15/93
Reactor#1 Detergent: **10 mL Brulin 815 GD (detergent = 0.053% [vol/vol])**
Reactor#2 Control
Reactor#3 Detergent: **10 mL Versa Clean (detergent = 0.053% [vol/vol])**

Incubation time frame: (5 Hours After Detergent Injection)

		Dish Wt. (g)	Dish & Sample Wt.(105 C)	Dish & Sample Wt.(550 C)	Total Solids (mg/L)	Volatile Solids (mg/L)	COD (mg/L)
Reactor#1	**Replicate**						
	A	1.2634	1.2692	1.2671	1160.0	740.0	21.0
	B	1.2596	1.2650	1.2631	1080.0	700.0	23.0
	C	1.2548	1.2605	1.2583	1140.0	700.0	23.0
Reactor#2	**Replicate**						
	A	1.2535	1.2602	1.2568	1340.0	660.0	12.0
	B	1.2576	1.2633	1.2607	1140.0	620.0	16.0
	C	1.2631	1.2693	1.2663	1240.0	640.0	16.0
Reactor#3	**Replicate**						
	A	1.2649	1.2696	1.2674	940.0	500.0	21.0
	B	1.2631	1.2689	1.2667	1160.0	720.0	23.0
	C	1.2640	1.2696	1.2672	1120.0	640.0	19.0
			Reactor#1	Avg.	1126.7	713.3	22.3
				C.V	3.0	2.6	4.2
			Reactor#2	Avg.	1240.0	640.0	14.7
				C.V.	6.6	2.6	12.9
			Reactor#3	Avg.	1073.3	620.0	21.0
				C.V.	8.9	14.7	7.8

SOLIDS REDUCTION & COD (PHASE #3)

Date: 6/17/93
Reactor#1 Detergent: **10 mL Brulin 815 GD (detergent = 0.053% [vol/vol])**
Reactor#2 Control
Reactor#3 Detergent: **10 mL Versa Clean (detergent = 0.053% [vol/vol])**

Sample Vol: 5.0 mL

Incubation time frame: (Before Detergent Injection)

		Dish Wt. (g)	Dish & Sample Wt.(105 C)	Dish & Sample Wt.(550 C)	Total Solids (mg/L)	Volatile Solids (mg/L)	COD (mg/L)
Reactor#1	**Replicate**						
	A	1.2571	1.2617	1.2604	920.0	660.0	19.0
	B	1.2672	1.2724	1.2708	1040.0	720.0	20.0
	C	1.2633	1.2678	1.2666	900.0	660.0	18.0
Reactor#2	**Replicate**						
	A	1.2686	1.2735	1.2720	980.0	680.0	11.0
	B	1.2618	1.2667	1.2648	980.0	600.0	11.0
	C	1.2603	1.2659	1.2649	1120.0	920.0	12.0
Reactor#3	**Replicate**						
	A	1.2702	1.2756	1.2740	1080.0	760.0	33.0
	B	1.2676	1.2730	1.2712	1080.0	720.0	24.0
	C	1.2690	1.2740	1.2722	1000.0	640.0	26.0
			Reactor#1	Avg.	953.3	680.0	19.0
				C.V	6.5	4.2	4.3
			Reactor#2	Avg.	1026.7	733.3	11.3
				C.V.	6.4	18.5	4.2
			Reactor#3	Avg.	1053.3	706.7	27.7
				C.V.	3.6	7.1	13.9

SOLIDS REDUCTION & COD (PHASE #3)

Date: 6/17/93
Reactor#1 Detergent: **10 mL Brulin 815 GD (detergent = 0.053% [vol/vol])**
Reactor#2 Control
Reactor#3 Detergent: **10 mL Versa Clean (detergent = 0.053% [vol/vol])**

Incubation time frame: (Time of Detergent Injection)

		Dish Wt. (g)	Dish & Sample Wt.(105 C)	Dish & Sample Wt.(550 C)	Total Solids (mg/L)	Volatile Solids (mg/L)	COD (mg/L)
Reactor#1	**Replicate**						
	A	1.2900	1.2950	1.2942	1000.0	840.0	36.0
	B	1.2903	1.2955	1.2938	1040.0	700.0	38.0
	C	1.2895	1.2945	1.2928	1000.0	660.0	37.0
Reactor#2	**Replicate**						
	A	1.2889	1.2943	1.2929	1080.0	800.0	NA
	B	1.2921	1.2977	1.2958	1120.0	740.0	NA
	C	1.3011	1.3065	1.3045	1080.0	680.0	NA
Reactor#3	**Replicate**						
	A	1.2686	1.2737	1.2719	1020.0	660.0	33.0
	B	1.2577	1.2623	1.2609	920.0	640.0	35.0
	C	1.2614	1.2667	1.2648	1060.0	680.0	34.0
			Reactor#1	Avg.	1013.3	733.3	37.0
				C.V	1.9	10.5	2.2
			Reactor#2	Avg.	1093.3	740.0	NA
				C.V.	1.7	6.6	NA
			Reactor#3	Avg.	1000.0	660.0	34.0
				C.V.	5.9	2.5	2.4

SOLIDS REDUCTION & COD (PHASE #3)

Date: 6/17/93
Reactor#1 Detergent: **10 mL Brulin 815 GD (detergent = 0.053% [vol/vol])**
Reactor#2 Control
Reactor#3 Detergent: **10 mL Versa Clean (detergent = 0.053% [vol/vol])**

Incubation time frame: (1 Hour After Detergent Injection)

		Dish Wt. (g)	Dish & Sample Wt.(105 C)	Dish & Sample Wt.(550 C)	Total Solids (mg/L)	Volatile Solids (mg/L)	COD (mg/L)
Reactor#1	**Replicate**						
	A	1.3074	1.3128	1.3120	1080.0	920.0	28.0
	B	1.2969	1.3022	1.3006	1060.0	740.0	30.0
	C	1.2997	1.3048	1.3033	1020.0	720.0	33.0
Reactor#2	**Replicate**						
	A	1.2977	1.3048	1.3017	1420.0	800.0	22.0
	B	1.2608	1.2660	1.2641	1040.0	660.0	21.0
	C	1.2624	1.2678	1.2659	1080.0	700.0	24.0
Reactor#3	**Replicate**						
	A	1.2974	1.3023	1.3006	980.0	640.0	24.0
	B	1.2965	1.3013	1.2996	960.0	620.0	31.0
	C	1.2929	1.2981	1.2963	1040.0	680.0	32.0
			Reactor#1 Avg.		1053.3	793.3	30.3
			C.V		2.4	11.3	6.8
			Reactor#2 Avg.		1180.0	720.0	22.3
			C.V.		14.4	8.2	5.6
			Reactor#3 Avg.		993.3	646.7	29.0
			C.V.		3.4	3.9	12.3

SOLIDS REDUCTION & COD (PHASE #3)

Date: 6/17/93
Reactor#1 Detergent: **10 mL Brulin 815 GD (detergent = 0.053% [vol/vol])**
Reactor#2 Control
Reactor#3 Detergent: **10 mL Versa Clean (detergent = 0.053% [vol/vol])**

Incubation time frame: (3 Hours After Detergent Injection)

		Dish Wt. (g)	Dish & Sample Wt.(105 C)	Dish & Sample Wt.(550 C)	Total Solids (mg/L)	Volatile Solids (mg/L)	COD (mg/L)
Reactor#1	**Replicate**						
	A	1.2887	1.2936	1.2922	980.0	700.0	27.0
	B	1.2870	1.2924	1.2908	1080.0	760.0	24.0
	C	1.2902	1.2954	1.2949	1040.0	940.0	22.0
Reactor#2	**Replicate**						
	A	1.2893	1.2947	1.2929	1080.0	720.0	6.0
	B	1.2926	1.2986	1.2965	1200.0	780.0	21.0
	C	1.2935	1.2990	1.2969	1100.0	680.0	16.0
Reactor#3	**Replicate**						
	A	1.2972	1.3037	1.3009	1300.0	740.0	20.0
	B	1.2858	1.2903	1.2890	900.0	640.0	9.0
	C	1.2966	1.3019	1.3016	1060.0	1000.0	21.0
			Reactor#1	Avg.	1033.3	800.0	24.3
				C.V	4.0	12.7	8.4
			Reactor#2	Avg.	1126.7	726.7	14.3
				C.V.	4.7	5.7	43.5
			Reactor#3	Avg.	1086.7	793.3	16.7
				C.V.	15.1	19.1	32.6

SOLIDS REDUCTION & COD (PHASE #3)

Date: 6/17/93
Reactor#1 Detergent: **10 mL Brulin 815 GD (detergent = 0.053% [vol/vol])**
Reactor#2 Control
Reactor#3 Detergent: **10 mL Versa Clean (detergent = 0.053% [vol/vol])**

Incubation time frame: (5 Hours After Detergent Injection)

		Dish Wt. (g)	Dish & Sample Wt.(105 C)	Dish & Sample Wt.(550 C)	Total Solids (mg/L)	Volatile Solids (mg/L)	COD (mg/L)
Reactor#1	**Replicate**						
	A	1.2852	1.2903	1.2890	1020.0	760.0	30.0
	B	1.2939	1.2986	1.2974	940.0	700.0	25.0
	C	1.2961	1.3014	1.2999	1060.0	760.0	27.0
Reactor#2	**Replicate**						
	A	1.3011	1.3067	1.3048	1120.0	740.0	16.0
	B	1.3020	1.3070	1.3051	1000.0	620.0	20.0
	C	1.3043	1.3096	1.3076	1060.0	660.0	22.0
Reactor#3	**Replicate**						
	A	1.3064	1.3111	1.3097	940.0	660.0	23.0
	B	1.2988	1.3037	1.3024	980.0	720.0	20.0
	C	1.3023	1.3067	1.3055	880.0	640.0	15.0
			Reactor#1	Avg.	1006.7	740.0	27.3
				C.V	5.0	3.8	7.5
			Reactor#2	Avg.	1060.0	673.3	19.3
				C.V.	4.6	7.4	12.9
			Reactor#3	Avg.	933.3	673.3	19.3
				C.V.	4.4	5.0	17.1

SOLIDS REDUCTION & COD (PHASE #3)

Date: 6/25/93
Reactor#1 Detergent: **10 mL Brulin 815 GD (detergent = 0.053% [vol/vol])**
Reactor#2 Control
Reactor#3 Detergent: **10 mL Versa Clean (detergent = 0.053% [vol/vol])**

Sample Vol: 5.0 mL

Incubation time frame: (Before Detergent Injection)

		Dish Wt. (g)	Dish & Sample Wt.(105 C)	Dish & Sample Wt.(550 C)	Total Solids (mg/L)	Volatile Solids (mg/L)	COD (mg/L)
Reactor#1	**Replicate**						
	A	1.2989	1.3035	1.3020	920.0	620.0	5.0
	B	1.2986	1.3026	1.3014	800.0	560.0	30.0
	C	1.2973	1.3017	1.3005	880.0	640.0	29.0
Reactor#2	**Replicate**						
	A	1.3020	1.3062	1.3046	840.0	520.0	34.0
	B	1.3026	1.3072	1.3054	920.0	560.0	33.0
	C	1.2991	1.3037	1.3021	920.0	600.0	35.0
Reactor#3	**Replicate**						
	A	1.2946	1.2989	1.2974	860.0	560.0	27.0
	B	1.2976	1.3023	1.3004	940.0	560.0	32.0
	C	1.2995	1.3041	1.3027	920.0	640.0	27.0
			Reactor#1	Avg.	866.7	606.7	21.3
				C.V	5.8	5.6	54.2
			Reactor#2	Avg.	893.3	560.0	34.0
				C.V.	4.2	5.8	2.4
			Reactor#3	Avg.	906.7	586.7	28.7
				C.V.	3.7	6.4	8.2

SOLIDS REDUCTION & COD (PHASE #3)

Date: 6/25/93
Reactor#1 Detergent: **10 mL Brulin 815 GD (detergent = 0.053% [vol/vol])**
Reactor#2 Control
Reactor#3 Detergent: **10 mL Versa Clean (detergent = 0.053% [vol/vol])**

Incubation time frame: (Time of Detergent Injection)

		Dish Wt. (g)	Dish & Sample Wt.(105 C)	Dish & Sample Wt.(550 C)	Total Solids (mg/L)	Volatile Solids (mg/L)	COD (mg/L)
Reactor#1	**Replicate**						
	A	1.3054	1.3101	1.3084	940.0	600.0	50.0
	B	1.3051	1.3102	1.3083	1020.0	640.0	52.0
	C	1.3061	1.3108	1.3093	940.0	640.0	33.0
Reactor#2	**Replicate**						
	A	NA	NA	NA	NA	NA	NA
	B	NA	NA	NA	NA	NA	NA
	C	NA	NA	NA	NA	NA	NA
Reactor#3	**Replicate**						
	A	1.2944	1.2992	1.2977	960.0	660.0	42.0
	B	1.2969	1.3013	1.2998	880.0	580.0	38.0
	C	1.3001	1.3050	1.3034	980.0	660.0	38.0
			Reactor#1 Avg.		966.7	626.7	45.0
			C.V		3.9	3.0	18.9
			Reactor#2 Avg.		NA	NA	NA
			C.V.		NA	NA	NA
			Reactor#3 Avg.		940.0	633.3	39.3
			C.V.		4.6	6.0	4.8

SOLIDS REDUCTION & COD (PHASE #3)

Date: 6/25/93
Reactor#1 Detergent: **10 mL Brulin 815 GD (detergent = 0.053% [vol/vol])**
Reactor#2 Control
Reactor#3 Detergent: **10 mL Versa Clean (detergent = 0.053% [vol/vol])**

Incubation time frame: (1 Hour After Detergent Injection)

		Dish Wt. (g)	Dish & Sample Wt.(105 C)	Dish & Sample Wt.(550 C)	Total Solids (mg/L)	Volatile Solids (mg/L)	COD (mg/L)
Reactor#1	**Replicate**						
	A	1.3037	1.3087	1.3070	1000.0	660.0	41.0
	B	1.2978	1.3021	1.3006	860.0	560.0	43.0
	C	1.3107	1.3154	1.3138	940.0	620.0	45.0
Reactor#2	**Replicate**						
	A	1.3079	1.3126	1.3107	940.0	560.0	36.0
	B	1.3085	1.3130	1.3115	900.0	600.0	30.0
	C	1.3133	1.3181	1.3163	960.0	600.0	28.0
Reactor#3	**Replicate**						
	A	1.3138	1.3188	1.3174	1000.0	720.0	36.0
	B	1.3030	1.3074	1.3057	880.0	540.0	40.0
	C	1.3041	1.3088	1.3073	940.0	640.0	38.0
			Reactor#1	Avg.	933.3	613.3	43.0
				C.V	6.1	6.7	3.8
			Reactor#2	Avg.	933.3	586.7	31.3
				C.V.	2.7	3.2	10.8
			Reactor#3	Avg.	940.0	633.3	38.0
				C.V.	5.2	11.6	4.3

SOLIDS REDUCTION & COD (PHASE #3)

Date: 6/25/93
Reactor#1 Detergent: **10 mL Brulin 815 GD (detergent = 0.053% [vol/vol])**
Reactor#2 Control
Reactor#3 Detergent: **10 mL Versa Clean (detergent = 0.053% [vol/vol])**

Incubation time frame: (3 Hours After Detergent Injection)

		Dish Wt. (g)	Dish & Sample Wt.(105 C)	Dish & Sample Wt.(550 C)	Total Solids (mg/L)	Volatile Solids (mg/L)	COD (mg/L)
Reactor#1	**Replicate**						
	A	1.2901	1.2950	1.2934	980.0	660.0	43.0
	B	1.2916	1.2966	1.2952	1000.0	720.0	40.0
	C	1.2957	1.3003	1.2986	920.0	580.0	45.0
Reactor#2	**Replicate**						
	A	1.2959	1.3009	1.2988	1000.0	580.0	31.0
	B	1.2893	1.2940	1.2925	940.0	640.0	35.0
	C	1.2930	1.2972	1.2958	840.0	560.0	34.0
Reactor#3	**Replicate**						
	A	1.2928	1.2976	1.2960	960.0	640.0	30.0
	B	1.2903	1.2946	1.2932	860.0	580.0	30.0
	C	1.2890	1.2938	1.2921	960.0	620.0	35.0
			Reactor#1	Avg.	966.7	653.3	42.7
				C.V	3.5	8.8	4.8
			Reactor#2	Avg.	926.7	593.3	33.3
				C.V.	7.1	5.7	5.1
			Reactor#3	Avg.	926.7	613.3	31.7
				C.V.	5.1	4.1	7.4

SOLIDS REDUCTION & COD (PHASE #3)

Date: 6/25/93
Reactor#1 Detergent: **10 mL Brulin 815 GD (detergent = 0.053% [vol/vol])**
Reactor#2 Control
Reactor#3 Detergent: **10 mL Versa Clean (detergent = 0.053% [vol/vol])**

Incubation time frame: (5 Hours After Detergent Injection)

		Dish Wt. (g)	Dish & Sample Wt.(105 C)	Dish & Sample Wt.(550 C)	Total Solids (mg/L)	Volatile Solids (mg/L)	COD (mg/L)
Reactor#1	**Replicate**						
	A	1.2942	1.2979	1.2966	740.0	480.0	39.0
	B	1.2882	1.2922	1.2909	800.0	540.0	41.0
	C	1.3056	1.3100	1.3084	880.0	560.0	39.0
Reactor#2	**Replicate**						
	A	1.3014	1.3062	1.3042	960.0	560.0	38.0
	B	1.2981	1.3020	1.3002	780.0	420.0	35.0
	C	1.2914	1.2957	1.2940	860.0	520.0	32.0
Reactor#3	**Replicate**						
	A	1.2955	1.3000	1.2981	900.0	520.0	34.0
	B	1.2969	1.3009	1.2992	800.0	460.0	36.0
	C	1.2934	1.2976	1.2959	840.0	500.0	34.0
			Reactor#1 Avg.		806.7	526.7	39.7
			C.V		7.1	6.5	2.4
			Reactor#2 Avg.		866.7	500.0	35.0
			C.V.		8.5	11.8	7.0
			Reactor#3 Avg.		846.7	493.3	34.7
			C.V.		4.9	5.1	2.7

Newark A.F.B. Detergent Biodegradability Study
Respiration Data (Phase #3)

Reactor #1: Formula 815 GD

% O2 Utilization per Minute

	Time (Hrs)				
Replicate	**Initial**	**0 hr**	**1 hr**	**3 hr**	**5 hr**
A	0.8947	0.9211	0.6053	0.6316	0.6053
B	0.3421	0.4474	0.4211	0.3684	0.3421
C	0.7895	0.5263	0.3421	0.3947	0.2895
Avg.	0.6754	0.6316	0.4562	0.4649	0.4123
St. Dev.	0.2396	0.2072	0.1103	0.1184	0.1382
C.V.	35.4710	32.8097	24.1742	25.4598	33.5073

Reactor #3: Versa Clean

% O2 Utilization per Minute

	Time (Hrs)				
Replicate	**Initial**	**0 hr**	**1 hr**	**3 hr**	**5 hr**
A	0.7895	0.8421	0.6316	0.4737	0.5000
B	0.8421	0.6579	0.3684	0.3421	0.3158
C	0.4474	0.5000	0.3947	0.3947	0.4737
Avg.	0.6930	0.6667	0.4649	0.4035	0.4298
St. Dev.	0.1750	0.1398	0.1184	0.0541	0.0813
C.V.	25.2508	20.9699	25.4598	13.4039	18.9249